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BRAIN DAMAGE AND THE SPIRAL AFTEREFFECT

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Abstract

Forty brain damaged mental hospital patients and forty non-organic psychiatric patients matched on age, sex, and length of hospitalization were tested with the Archimedes spiral following pretraining with stimulus situations which involved actual rather than illusory expansion and contraction. Subgroups of each type of patient were examined under immediate and delayed response conditions following fixation of the Archimedes spiral on a series of test trials. Estimates of the duration of the spiral aftereffect (SAE) were taken, along with measures of response latencies and continuous GSR records.

The results confirmed the expectation that brain damaged Ss under immediate response conditions would report perception of the SAE as frequently as a control group of comparable non-organic psychiatric patients. Fifteen of the twenty brain damaged Ss under immediate response conditions reported the SAE on six or more of the eight test trials. All of the brain damaged Ss in this condition reported the SAE on at least one of the test trials.

The results also supported the prediction that Ss under delayed response conditions would give significantly fewer responses indicating perception of the SAE than Ss under immediate response conditions.

Neither age, length of hospitalization, nor visual acuity significantly differentiated any of the subgroups in terms of frequency of SAE report. No significant differences were found between the organic subgroups and the corresponding control groups in frequency of SAE report on successive test trials. None of the subgroups differed significantly in terms of the duration of the SAE.

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I. Introduction

The Archimedes spiral consists of a white disc with a painted black line spiralling outwards from the center. It is generally attached to a turntable and a motor which allows rotation of the spiral at varying speeds in either direction. When a person fixates the center point of the rotating spiral for a number of seconds and is then asked to describe what is happening to the spiral after the rotation has been abruptly terminated, he will report experiencing apparent movement. If during the fixation period the spiral is seen as expanding or approaching, upon the cessation of rotation the spiral aftereffect will be experienced as an apparent contraction or recession of the spiral. Usually, the spiral aftereffect (SAE) of expansion is induced more easily (Berger, Everson, Rutledge, and Koskoff, 1958) and can be experienced after shorter periods of stimulation with the rotating spiral (Costello, 1960) than the aftereffect of contraction.

A number of factors have been isolated which seem to have marked effects on the characteristics of the SAE experience. The presence of contours on the disc

does not seem to be necessary (Spitz, 1958) but texture appears to be an essential element (Griffith & Spitz, 1959). On the other hand, the aftereffect is not restricted to the disc and can be experienced on virtually any object in the surrounding environment (Spitz, 1958; Griffith & Spitz, 1959; Holland, 1960). With normal Ss the duration of the experience seems to bear a positive logarithmic relationship to speed of rotation and duration of inspection of the spiral (Dickinson, 1959). This relationship seems to hold fairly well within a wide range of limits, only breaking down following inspection periods greater than 80 seconds (Holland, 1960). Visual fixation seems essential, and if it is not maintained throughout the inspection period, the experience is usually quite weak or nonexistent (Day, 1960; Holland, 1960). The visual angle subtended by the disc also seems to be a relevant parameter and the optimal retinal size appears to fall in the region of 2-4 degrees va., 0 degrees pa. (Holland, 1960).

Problem

The Archimedes spiral was first used as a clinical test for the diagnosis of brain damage by Price and Deabler in 1955. It was found that brain-injured

patients failed significantly more frequently to report perception of the spiral aftereffect (SAE) than did control groups of normals and functional psychiatric Ss. Only 2 per cent of the organic Ss obtained perfect scores whereas 95 per cent of the functional psychiatric and 92.5 per cent of the normal Ss obtained such scores on four test trials. Similar findings were reported by Gallese (1956) in a subsequent validation study. Using three correct responses on four test trials as the criterion for a successful performance it was found that a considerable percentage of the brain-injured group was correctly identified and only a few of the schizophrenics, lobotomized schizophrenics, and normals were misclassified. The findings of Davids, Goldenberg, and Laufer (1957), and Gilberstadt, Schein, and Rosen (1958) essentially confirmed those of Price and Deabler, and Gallese. In the former study only 13 per cent of the organic group obtained perfect scores while in the latter 16.6 per cent of the organic sample achieved the criterion for success.

Another study (Berger, Everson, Rutledge, and Koskoff, 1958), based on a somewhat similar sample to that used in the Gilberstadt, et al., investigation, likewise indicated the presence of a relationship between estimated

brain damage and SAE performance. In addition significant relationships were established between SAE scores and visual acuity, spinal fluid examinations, visual field tests, and global judgments of the likelihood of brain damage. On the other hand, the predicted relationship between test performance and EEG reports, pneumo-encephalograms, and skull X-rays was not confirmed. Page, Rakita, Kaplan, and Smith (1957) failed to obtain significant rank correlations between duration of the SAE and age, education, and length of hospitalization. Aaronson (1958), similarly failed to establish a relationship between SAE scores and age but concluded that a poor test performance might be associated with low I.Q., anomia, the number of different sensory avenues impaired, visual and auditory impairment, and right-sided sensory impairment.

Most of these researchers have generally concluded, either explicitly or implicitly, that neurophysiological damage is exclusively responsible for poor performance on the SAE test. Shapiro (1954), for example, has suggested that perception of apparent movement is related to an "irradiation of excitatory effects" and that there is "an exaggeration of inhibitory effects" in brain-injured patients which destroys or weakens perception of the

aftereffect. Saucer and Deabler (1956), on the other hand, have theorized that perception of the SAE is a function of global activity of the entire cortex and that lesions in the brain-injured patient disrupts this process thus resulting in a failure to experience the phenomenon. Klein and Krech (1952) have proposed that brain damaged patients have a lower level of "cortical conductivity" and thus will exhibit greater figural aftereffects but Spivack and Levine (1959) have failed to obtain any significant intercorrelations between figural aftereffect scores, performance on the SAE and rates of reversal of figures giving reversible perspective. These latter authors offered the alternative hypothesis that the brain-injured individual's performance may be due to a "process of overcorrection by pathological tissue for whatever process is set up by the spinning spiral."

The assumption made by these theorists seems to be that the brain-injury per se interferes in some way with the perceptual experiences of brain damaged Ss on the SAE task. Notwithstanding the repeated findings that performance does not appear to be related to locus of the injury, severity of the damage, degree of chronicity, and a host of other variables, theorists and investigators

have been reluctant to examine alternative hypotheses (cf. Berger, <u>et al</u>., 1958).

More recently, however, some enquiries have been directed at an examination of the possibility that psychological as opposed to organic factors may account for the failure of brain damaged <u>S</u>s to report perception of the SAE. For example, Schein (1960) in an investigation of the duration of the SAE found that only ten of 123 male veterans admitted to a neurology ward failed to report the aftereffect on half or more of ten test trials in which a black circle drawn on white cardboard and a three-dimensional orange block were used for elicitation of reports following stimulation with the rotating spiral. The suggestion was made that some of the failures to report the SAE may be the result of confusion about the task on the part of brain-injured patients. Mayer and Coons (1960) in a study relating motivational factors to SAE performance reported that under reassuring instructions prior to examination with the Archimedes spiral functional psychiatric and organic groups were not significantly different in frequency of SAE reporting. Under anxiety-arousing and neutral instructions, however, organic groups were significantly inferior to psychiatric

control groups in terms of frequency of SAE report. It was concluded that the characteristic anxiety of most brain-injured patients (Goldstein, 1936; Goldstein, 1952; Coons, 1956) was chiefly responsible for their inferior performance.

The results of the studies just cited cast doubt on the tenability of a "physiological hypothesis" to account for the performance of "organic" Ss. In support of a "psychological hypothesis" the combined evidence strongly suggests that confusion about the task, and anxiety may be important psychological factors which affect the frequency of SAE report of brain damaged patients. In addition, it may be that unless measures are taken at the outset to minimize the possible effects of these factors on brain damaged individuals, the validity of verbal reports as indicators of their perceptual experiences may be seriously questioned. The purpose of the present investigation was to determine whether or not conditions could be arranged so that brain-injured patients would report the SAE in the context of a technique which would permit valid inferences from their verbal reports.

Gollin and Bradford (1958) in their investigation of the problem of communication in relation to SAE performance examined twenty-three normal children with a

chronological age range of 38 months to 63 months and reported that seventeen of the twenty-three Ss achieved the success criterion on the SAE following brief pretraining with stimulus situations which involved "actual" rather than illusory expansion and contraction. These investigators concluded that failure to report SAE may be due to the "unavailability of the necessary verbal designators rather than upon perceptual deficit." Large white balloons with spirals painted on them were presented during what were called "pre- and postfixation periods". Just prior to being tested with the Archimedes spiral the Ss were asked to view an inflating, deflating, and stationary balloon and to tell the experimenter whether it was "getting bigger", "getting smaller", or "staying the same size". This prefixation procedure was followed by the presentation of a rotating Archimedes spiral mounted on an 11½-inch disc for fixation purposes. The postfixation period consisted of the presentation of the stationary balloon in front of the rotating spiral (obscuring it) for elicitation of the illusory aftereffect. The idea here was to establish the availability of the appropriate verbal responses to "actual" rather than "illusory" expansion and contraction before making any presentation

of the rotating spiral for fixation purposes. The findings were reported as evidence that the balloon-spiral technique facilitated the evocation of correct responses when the conditions for perception of the genuine aftereffect were presented.

Gollin and Bradford however, did not provide any detailed discussion as to why balloon-spirals were used and how correct responses were facilitated by this technique. A striking feature of the SAE which has been noted by Spitz (1958) is that the afterimage does not start at any specific point on the disc, such as the center or the periphery, but rather it is a <u>simultaneous</u> movement of the entire surface of the disc much as if a balloon were inflating or deflating. It can be seen that the inflation or deflation of the balloon-spirals in the Gollin and Bradford study produces actual simultaneous movement which closely approximates the nature of the illusory SAE. It may be reasonable to speculate therefore that stimulus generalization was operative under the conditions of their investigation. Probably the actual movement of the expanding or contracting balloon-spirals presented during the prefixation period had stimulus characteristics which

were essentially similar to the stimulus properties of the illusory movement of expansion or contraction perceived on the stationary balloon-spiral presented during the postfixation period. The responses which were associated with actual movement during prefixation training were readily emitted under postfixation (illusory) conditions because the properties of the two stimulus conditions were highly similar.

The merits of the Gollin and Bradford balloon-spiral technique appear to be two-fold, viz., ambiguities in the verbal reports of Ss are largely eliminated, and perception of the SAE, or the inability to perceive it, is likely to be accurately reflected in the responses given by Ss. Restricting verbal reports to three response alternatives clearly removes the necessity for interpretations on the part of the experimenter, and perhaps significantly reduces the confusion and anxiety of Ss when confronted with the ambiguous stimuli associated with the SAE. Accuracy in the responses given by Ss can be expected because experience with the balloon-spirals prior to SAE testing should facilitate recognition of relevant stimulus characteristics and decrease possible "interference effects" from irrelevant stimulus characteristics associated with the stationary postfixation balloon-spiral.

Since there is reason to believe that brain damaged patients are unwilling or unable to respond accurately in the SAE test situation the Gollin and Bradford technique may provide, in modified form, an effective method in which verbal reports elicited from them could be accepted as valid indicators of their perceptual experiences. Expanding the pretest experience with the balloon-spirals into an extended training series should materially improve the effectiveness of the technique. This procedure would enable the brain-injured S to become familiar with the demands of a task which has been made easy and relatively concrete, and in which his responses could be given more or less automatically as the training progressed. It is hypothesized that the brain-injured Ss' confusion, anxiety, and apprehension, which may be manifested in failure to accurately report the nature of their perceptual experiences, will be significantly reduced by the proposed procedure. The prediction is made that brain damaged Ss will report the SAE under these conditions as frequently as a control group of comparable functional psychiatric Ss.

A secondary aim of the investigation will be to examine some aspects of the vividness of the aftereffect

for brain-injured Ss. This problem has received little attention from most investigators and the scanty evidence available appears to be inconclusive. Gallese (1956) noted that the SAE was less marked and of shorter duration for brain damaged Ss who reported perception of the SAE than it was for control Ss. No differences in the duration of the SAE of brain-injured and schizophrenic Ss were observed by Page, Rakita, Kaplan, and Smith (1957). Schein (1960) likewise failed to secure differences between brain-injured Ss and control groups of psychotic, neurotic, and hospitalized normals on duration estimates. In addition his results indicated that neither age, intelligence, drugs, nor diagnosis differentiated the groups with regard to duration of the SAE. In direct contradiction to these three studies, Spivack and Levine (1957) found that duration of the SAE was significantly longer for the brain damaged group than it was for a normal control group.

The contradictory nature of the findings on duration of the SAE precludes the formulation of any sound predictive statements about differences in the duration of the SAE between brain damaged and functional psychiatric Ss or other control groups. However, manipulation of the time interval between the fixation period and the post-fixation period in this experiment may provide useful data about some aspects

of the nature of the perceived aftereffect. It is hypothesized that responses from Ss when the exposure of the postfixation balloon-spiral is delayed for 10 seconds will reflect a reduction in the vividness of the SAE. The rationale behind this hypothesis is that as the SAE becomes weaker or less vivid during such a delay period the stimulus characteristics of the postfixation balloon-spiral will change in such a way as to no longer remain similar to the stimulus properties of the inflating or deflating balloon-spirals used in the prefixation training series. Further, as the intensity of the SAE diminishes to the point of perhaps disappearing altogether before the delay time has elapsed the stimulus characteristics of the postfixation balloon-spiral will be essentially identical to the stimulus properties of the stationary balloon-spiral used in the training series.

The prediction is made that following ten seconds of delay Ss will give fewer responses indicating perception of the SAE than Ss under "immediate" conditions (i.e., no delay interval following the fixation periods). It is also predicted that Ss will show longer response latencies under "delayed" conditions than Ss who have been examined under "immediate" conditions.

II. Method

Subjects

Forty brain-injured patients (33 male and seven female) from the Ontario Hospital Hamilton were randomly assigned to two organic subgroups of twenty patients each. Ss assigned to Organic Group 1 were tested under "immediate" conditions and Ss placed in Organic Group 2 were tested under "delay" conditions. These Ss ranged in age from 28.1 years to 75.0 years at the time of testing and included cases with CNS syphilis (N = 16), juvenile neurosyphilis (N = 2), post-encephalic parkinsonism (N = 4), Huntington's chorea (N = 2), Korsakoff's psychosis (N = 8), Korsakoff's and Wernicke's encephalopathy (N = 1), nonspecific cerebral atrophy (N = 2), psychosis secondary to disease of the CNS (N = 2), psychosis with cerebral arteriosclerosis (N = 2), and post-traumatic psychosis (N = 1). The length of hospitalization for the forty brain damaged patients ranged from one month to 29.1 years.

Two control groups (one for each experimental condition) of twenty functional psychiatric patients were matched with the brain damaged patients on age and length of hospitalization. Only those patients who showed no clinical features suggestive of organic pathology were

included in the functional psychiatric groups. Ss in these groups (33 male and seven female) included cases of paranoid schizophrenia (N = 14), paranoid state (N = 1), catatonic schizophrenia (N = 9), undifferentiated schizophrenia (N = 1), simple schizophrenia (N = 2), manic-depressive psychosis (N = 5), without psychosis (N = 2), neurotic depressive reaction (N = 5), and mixed neurosis (N = 1). No patient was included in the control groups who underwent electroshock treatment during a three month period prior to being tested because it has been shown (Kalinowsky, 1945) that EST produces symptoms reminiscent of those associated with brain damage.

Due to the uncertainty of drug effects all Ss, including the brain damaged Ss, were taken off medication for 48 hours prior to being tested. No patient with mental deficiency was included in the sample.

Table 1 summarizes the mean ages, lengths of

Table 1

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hospitalization, and visual acuity scores for the four subgroups. Analysis of differences between the groups on these three variables indicated that the groups did

Table 1

Mean Age, Length of Hospitalization
and Visual Acuity for All Ss

	Age in Years		Months of Hospitalization (Square-root transformation)		Visual Acuity (Square-root transformation)	
Group	$\overline{X}$	S.D.	$\overline{X}$	S.D.	$\overline{X}$	S.D.
Organics 1	53.49	11.25	8.181	3.59	6.235	1.96
Organics 2	51.56	10.01	6.810	4.43	6.137	1.75
Functionals 1	53.10	11.22	8.564	3.50	5.940	1.31
Functionals 2	51.16	10.60	7.754	4.37	5.395	1.18

Note. - No statististically significant differences were found between any of the groups on any of the variables.

not differ significantly on any one of them.

Apparatus

Black spirals were painted opposite the nozzles of large white paddle balloons which when inflated had a diameter of approximately fifteen inches. Inflation was accomplished by means of compressed air. The hissing noise accompanying the inflation was also maintained during the deflating and stationary presentations throughout the training series and during the postfixation presentations of the stationary balloon-spirals. The spirals painted on the balloons were identical, as nearly as possible, with the spiral disc used in the fixation periods in terms of width of lines, overall size and shape, and visual angle subtended. The spiral used for fixation purposes was eight inches in diameter, two and one-half turns about the center, and mounted vertically on the axle of a motor which produced the rotation. The direction of rotation of the spiral was reversed by means of a switching arrangement for producing the expanding aftereffect and the contracting aftereffect. The pre- and postfixation balloon-spirals and the spiral used for fixation purposes were at eye level and approximately eight feel in front of the S. The spiral

used in the fixation period was presented at a rotational speed of 100 r.p.m. for a duration of 45 seconds. These conditions are approximately optimal for elicitation of the SAE (Dickinson, 1959; Sindberg, 1961). In addition it has been shown (Schein, 1960; Whitmyre and Kurtzke, 1962) that the same proportions of brain damaged and functional psychiatric patients fail to report perception of the SAE at varying exposure times (including 10, 20, 30, 40, and 50 second intervals).

Continuous measures of level of emotional arousal were obtained from Ss with a GSR pen-recorder commercially available from the C. H. Stoelting Company of Chicago (model number 24203). An events-pen was added to this equipment in order to have a continuous record of stimulus presentations.

Response latencies were registered by means of an electronic voice key and a Standard Electric timer. Mechanical release of a micro-switch at the moment of stimulus presentation started the timer and S's verbal response into a microphone stopped the clock.

A Snellen chart placed eighteen feet away from the S was used to assess visual acuity. Scoring and administration procedures for visual acuity were the same as in the Berger, et al., (1958) study.

Procedure

All Ss were examined by the same experimenter under conditions of uniform illumination. Examination of a brain damaged S was always followed by that of a functional psychiatric S throughout the one month duration of the experiment.

At the outset of testing Ss were told that they were shortly to undergo a series of special eye examinations. Following administration of the test for visual acuity the S was seated at a table, approximately eight feet away from the concealed Archimedes spiral and the other equipment. Only the GSR electrodes and the microphone of the voice key were visible to the S. The remainder of the apparatus was concealed from view by means of a large hard-board screen with appropriate sliding shutters for stimulus presentations. A brief description of the purpose of the microphone and the GSR electrodes was given and following placement of the electrodes the S was reassured that they were in no way harmful or dangerous. The experimenter then presented the stationary balloon-spiral and proceeded with the following instructions.

"See this design? It's called a spiral. You can see how the black line here starts in the center and goes outwards.... Now I am going to show you this balloon a

number of times in different ways. Sometimes the spiral will be'getting bigger', sometimes it will be 'getting smaller', and at other times it will not change in size in any way.... it will be 'staying the same size'. Your job will be to look at the spiral each time I show it to you and tell me whether it is 'getting bigger', or 'getting smaller' or 'staying the same size'. Each time that you give the correct answer I will say 'good' or 'that's right'. Whenever you give the wrong answer I will say nothing. Now, I will show you this balloon-spiral in these three different ways a number of times in a mixed-up order. You are to learn to give your answers as quickly as you can, O. K.? Now, just one more thing. Each time I show you the balloon-spiral you will hear a loud hissing noise (demonstration). That noise comes from a cylinder of compressed air which will be used to blow-up the balloons. Try as much as you can to ignore the sound, O.K.? .... Ready?"

The training series consisted of forty-five trials in which the inflating, deflating, and stationary balloon-spirals were each presented fifteen times. The order of presentation was such that the inflating, deflating, and stationary balloon-spirals were presented five times in successive blocks of fifteen training trials. Within each of the three blocks order of presentation was randomized.

Immediately after the end of the training series (prefixation period) the experimenter proceeded with the following instructions.

"From now on I won't tell you whether you are right or wrong but I will keep track on this paper here just as I have been doing all along, O. K.?.... Now, when I open this shutter you will see another spiral. This time it will be turning. All I want you to do is to keep your eyes on the very center of the spiral until I tell you to stop". Continued encouragement was given if necessary, to fixate the center point of the rotating spiral (fixation period). At the end of each fixation period (45 seconds) the experimenter obscured the inspection stimulus (rotating spiral) and immediately exposed the stationary balloon-spiral in the same position as it was during the training series (i.e., two feet to the left of the test spiral, relative to S) with the following instructions.

"Now look at this spiral and tell me about it as quickly as you can".

The same instructions were administered to all Ss in both experimental conditions. During any single experimental session the same balloon-spiral was used for pre- and postfixation purposes and the terminal point

of the spiral painted on its surface was always presented to the left of the seated S.

The test series consisted of eight trials. Each test trial involved presentation of either the clockwise rotating or counter-clockwise rotating spiral for 45 seconds of fixation followed by inspection of the stationary balloon-spiral. Rest periods of sixty seconds were allowed between the first six test trials. The seventh and eighth test trials were preceded by a three-minute rest interval. If the S gave responses indicating perception of the SAE on the last two test trials, estimates of the duration of the aftereffect were made using a stopwatch and the S's verbal report of the cessation of movement.

Order of presentation effects on the test series and possible perseveration were minimized in the following way. A series of random orders of presentation of the clockwise rotating and counter-clockwise rotating spirals was used with the restriction that across all Ss in "condition 1" each of the spirals was presented an equal number of times in each of the first six serial positions. The last two trials consisted of one presentation of each of the spirals with alternation of presentation order over Ss. The reverse order of presentation of the spirals was used for Ss in "condition 2".

III. Results

The frequency distribution of scores indicating perception of the SAE is shown in Table 2. It can be seen

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Table 2

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that in terms of frequency of aftereffect report brain damaged groups in either experimental condition were not statistically distinguishable from the functional groups in the corresponding experimental conditions. The results indicated in Table 2 also supported the prediction that Ss under "delay" conditions would give significantly fewer responses indicating perception of the SAE than Ss under "immediate" conditions. The frequency of aftereffect report of brain-injured Ss in Condition 1 ("immediate") was significantly better ($p < .05$) than that of brain damaged Ss in Condition 2 ("delay"). Similarly, functional psychiatric patients reported perception of the SAE significantly more often in Condition 1 than in Condition 2 ($p < .001$).

Comparisons were made between the subgroups in terms of frequency of aftereffect report to the expanding

Table 2

Distribution of Spiral Aftereffect

Scores

(N = 20 in each group)

Subject Group	Score 0	1	2	3	4	5	6	7	8
1. Organic 1	0	1	0	4	0	0	2	4	9
2. Organic 2	1	0	3	2	3	2	2	2	5
3. Functional 1	0	0	0	0	0	3	3	3	11
4. Functional 2	0	3	2	1	1	4	4	1	4

1 x 2	$\underline{Z} = 1.63$[a]	$\underline{p}$ .0516
3 x 4	$\underline{Z} = 3.09$[a]	$\underline{p}$ .001
1 x 3	$\underline{T} = 38.0$[b]	$\underline{p}$ is N.S.
2 x 4	$\underline{T} = 74.5$[b]	$\underline{p}$ is N.S.

[a] Mann-Whitney U test, normal approximation, corrected for ties.

[b] Wilcoxon matched-pairs signed ranks test.

and to the contracting aftereffects. Results shown in Table 3 indicate that Organic Ss in Condition 1 reported

Table 3

perception of the expanding aftereffect (EAE) as frequently as did the Functional Ss in Condition 1. Similarly these two groups did not differ significantly in frequency of report of the contracting aftereffect (CAE). Analysis of the scores obtained by the two subgroups in Condition 2 likewise failed to yield significant differences in frequency of report of the expanding aftereffect and the contracting aftereffect.

The results shown in Table 4 failed to support

Table 4

the hypothesis that Ss would show longer response latencies on the test series under "delay" conditions than under "immediate" conditions. No statistically significant differences were found between any of the groups in terms of mean response latencies. However, relationships were established between response latencies on the test series and frequency of report of the SAE. Results shown in

Table 3

Comparisons of Groups in the
Same Experimental Condition on
Frequency of Report
of the Expanding Aftereffect (EAE)
and the Contracting Aftereffect (CAE)

Group	Number of Pairs	T^a	Level of Significance
EAE Report Organic 1 Functional 1	8	5.0	N.S.
EAE Report Organic 2 Functional 2	13	40.5	N.S.
CAE Report Organic 1 Functional 1	13	32.5	N.S.
CAE Report Organic 2 Functional 2	17	69.5	N.S.

[a] Wilcoxon matched-pairs signed ranks test.

Table 4
Comparison of Group Differences
in Response Latencies
in Seconds

	Response Latencies on Test Series	
Group	Mean	S. D.
Organic 1	2.11	2.03
Organic 2	1.89	1.07
Functional 1	1.46	1.41
Functional 2	1.52	2.25

Note. - No significant differences were found between any of the groups.

Table 5 indicate rank correlations of +.62, +.74, and +.47

Table 5

were found between response latencies and SAE scores for Organics in Condition 1, Functionals in Condition 1, and Functionals in Condition 2, respectively. No significant correlation between these two variables was established for Organics in Condition 2.

Results on the duration of the perceived aftereffect were based on estimates taken on the last two test trials. Since a minority of Ss in each sub-group failed to give responses indicating perception of the SAE on one or both of the last two test trials, these were excluded in the statistical analysis of the findings on the duration of the afterimage as summarized in Tables 6 and 7.

Table 6 and 7

Neither of the two brain damaged groups were statistically distinguishable from their corresponding control groups in terms of duration of the expanding aftereffect nor the contracting aftereffect. Differences

Table 5

Spearman Rank Correlations Between
Mean Response Latencies (RT) on the Test
Series and Aftereffect Scores (SAE)
(Normal approximations, corrected for ties)

Group	Sums of Squares on RT	Sums of Squares on SAE Scores	Sums of Squares of Differences	r_s	p*
Organic 1	665	594.5	484.5	+.62	.01
Organic 2	665	649	1043	+.18	--
Functional 1	664	549	317	+.74	.01
Functional 2	664.5	647.5	702	+.47	.01

Note. - N = 20 in each group in each condition.

* _p_ values taken from Seigel, S., _Nonparametric Statistics_, N.Y., 1956.

Table 6

Comparisons of Group Differences in Duration of the Expanding Aftereffect

Group	N.	Mean Duration in Seconds	S.D.	t for Difference	p (two-tailed)
Organic 1	16	18.44	9.75	1.74	$>.05$
Organic 2	14	25.29	11.02		
Functional 1	19	14.68	4.04	3.31	$<.01$
Functional 2	13	18.85	2.11		
Organic 1	15	18.40		1.62	---
Functional 1	15	14.07			
Organic 2	9	24.00		.84	---
Functional 2	9	18.00			

Table 7

Comparisons of Group Differences in Duration of the Contracting Aftereffect

Group	N	Mean Duration in Seconds	S.D.	*t* for Difference*
Organic 1	15	17.53	10.54	1.57
Organic 2	9	24.56	9.58	
Functional 1	17	15.76	10.14	1.32
Functional 2	10	20.30	3.52	
Organic 1	15	17.53		.47
Functional 1	17	15.76		
Organic 2	9	24.56		1.24
Functional 2	10	20.30		

* p was non-significant for each comparison made.

in duration of the contracting aftereffect were non-significant in a comparison of Organics in Condition 1 versus Organics in Condition 2, and Functionals in Condition 1 versus the Functionals in Condition 2. The only statistically significant difference in duration of either afterimage was obtained in a comparison of the Functionals in Condition 1 and the Functionals in Condition 2 on the expanding aftereffect. Analysis using the t test showed that Functionals Ss in Condition 1 reported seeing the expanding aftereffect for a significantly shorter period of time than Functionals in Condition 2.

Comparisons made within the subgroups in terms of duration of the two aftereffects are shown in Table 8.

Table 8

No significant differences were found within any of the subgroups on duration of the expanding aftereffect versus the contracting aftereffect.

Analysis of the GSR recordings made throughout the experiment indicated that an overwhelmingly large proportion of Ss showed decreases in level of emotional arousal from the beginning of training to the end of the

Table 8

Comparison of Group Differences
Between Duration of the Expanding
Aftereffect (EAE) and the Contracting
Aftereffect (CAE)[a]

Group	N.	Mean in Seconds	Sum of Squares of Differences	Variance of Differences	*t* for Mean Difference
Organic 1:					
Duration of EAE	14	18.86	197	12.22	1.40
Duration of CAE	14	17.50			
Functional 1:					
Duration of EAE	16	13.94	1505	91.63	.63
Duration of CAE	16	15.50			
Organic 2:					
Duration of EAE	7	28.4	229	25.4	1.32
Duration of CAE	7	25.7			
Functional 2:					
Duration of EAE	9	18.8	104	9.79	1.20
Duration of CAE	9	20.1			

[a] Analyses were based only on duration estimates of Ss who reported both the EAE and CAE on the last two test trials.

Note. - *p* is non-significant for each comparison made.

training series ("A versus B" in Table 9). Similarly a large proportion of the Ss showed a lower level of emotional arousal at the outset of the test series than they did at the outset of the training series ("A versus C" in Table 9).

Table 9

The proportion of brain damaged patients who showed decreases in level of emotional arousal during the experiment was not significantly different from the proportion of functional psychiatric patients showing such decreases.

Performance of Ss on the training series of 45 trials is summarized in Tables 10 and 11. The results

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Table 10

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shown in Table 10 indicated that the Organic Ss in Condition 1 did not differ significantly in terms of mean number of errors from the Organic group in Condition 2 but the latter group made significantly more errors than the Functional Ss in Condition 2 ($p < .05$). A comparison of the differences in mean number of errors between the two functional groups indicated that they were not

Table 9

Comparison of Changes
in Level of Anxiety Within Groups
at the Outset of Training (A), at the End of Training (B),
and at the Outset of the Test Series

(McNemar Test for Significance of Changes, Corrected for continuity)

Group	Number of Ss Showing Decreases −	Number of Ss Showing Increases +	Chi-Squared	Level of Significance
Organic 1				
(A vs. B)	16	2	9.39	$< .005$[a]
(A vs. C)	15	2	8.47	$< .005$[a]
(B vs. C)	5	9	.64	N.S.
Organic 2				
(A vs. B)	15	2	8.47	$< .005$[a]
(A vs. C)	14	1	9.60	$< .005$[a]
(B vs. C)	9	2	3.27	N.S.[b]
Functional 1				
(A vs. B)	19	0	17.05	$< .0005$[a]
(A vs. C)	13	5	2.72	$< .05$[a]
(B vs. C)	4	14	4.50	$< .05$[b]
Functional 2				
(A vs. B)	17	2	10.32	$< .005$[a]
(A vs. C)	13	5	2.72	$< .05$[a]
(B vs. C)	7	10	.24	N.S.

Note. – "A" is based on mean GSR on first five training trials for each S.
"B" is based on mean GSR on last five training trials for each S.
"C" is based on the highest GSR obtained during the first ten seconds of the first testtrial for each S.

[a] One-tailed p values.

[b] Two-tailed p values.

Table 10

Comparison of Group Differences

in Number of Training Errors

Group	Errors During Training	
	Mean	S.D.
1. Organic 1	6.90	4.95
2. Organic 2	8.80	6.79
3. Functional 1	7.05	5.73
4. Functional 2	4.95	4.72

	t	p
1. versus 2.	< 1	N.S.
3. versus 4.	1.24	N.S.
1. versus 3.	< 1	N.S.
2. versus 4.	2.31	< .05

statistically distinguishable on this variable.

In order to evaluate the possibility that Organic *S*s may have differed from Functional *S*s at the beginning of training Wilcoxon matched-pairs signed ranks tests were made on error scores obtained by *S*s during successive blocks of fifteen training trials. This analysis, summarized in Table 11, failed to reveal any significant differences

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Table 11

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between Organics and Functionals in terms of mean number of errors on any of the three blocks.

No consistent temporal effects were found when a test-trial by test-trial comparison was made of the number of Organic *S*s who failed to report the SAE and the number of functional psychiatric *S*s who likewise failed to report the SAE.

Rank correlations between age, length of hospitalization, and visual acuity scores, with frequency of aftereffect report (.121, -.103, .167, respectively) were all non-significant.

Table 11

Comparison of Group Differences

in Number of Training Errors

by Blocks of Fifteen Trials

Group	Errors During Training		T	Z*
	Mean	S.D.		
First Block				
Organics	3.58	2.28	273.0	1.18
Functionals	2.98	2.21		
Second Block				
Organics	2.48	2.50	248.0	1.56
Functionals	1.60	2.00		
Last Block				
Organics	1.80	2.23	194.0	1.06
Functionals	1.43	2.00		

Note. - Wilcoxon matched-pairs signed ranks test.

* p was non-significant for each comparison made.

IV. Discussion

The results of the present investigation have confirmed the expectation that under the conditions of this experiment brain damaged Ss would report the SAE as frequently as comparable functional psychiatric Ss. Fifteen of the twenty brain-injured Ss in Condition 1, the condition most closely resembling that found in other studies, reported the SAE on six or more of the eight test trials. Furthermore none of the brain-injured Ss in Condition 1 failed to report the SAE on all of the eight test trials. These results seem to support the contention of those investigators (Gollin and Bradford, 1958; Schein, 1960; and Mayer and Coons, 1960) who have argued that the characteristic failure of brain-injured patients to report the SAE may not necessarily indicate failure to experience the phenomenon. In addition these findings tend to suggest as premature, the adoption of neurophysiological theories to account for the characteristically inferior performance of brain damaged Ss. The neurophysiological theories proposed by Klein and Krech (1952), Shapiro (1954), Saucer and Deabler (1956), and Spivack and Levine (1959) appear to rest on the assumption that brain damaged patients are unable to experience the

SAE. The high incidence of SAE reports elicited from the brain damaged patients in Condition 1 of this study indicates that such an assumption may be untenable. A possible major implication of these findings is that considerable caution should be exercised in placing undue reliance on verbal reports elicited from brain damaged patients under conditions where they may become anxious and confused by the demands of the task.

The inconsistency of the findings of the present study with those reported by Price and Deabler (1955), and by subsequent investigators who have found that brain-injured patients fail to report the SAE may be due primarily to differences in procedure. In this study a pre-test training series of 45 trials was used on the assumption that restriction of response alternatives and the conditioning of these responses to stimuli similar to those encountered during the test series would reduce the possible confusion, apprehension, and anxiety on the part of brain damaged Ss and would facilitate a "readiness" to respond accurately when the conditions for the genuine SAE were presented. Results obtained on the performance of Ss on the training series seemed to support this contention. The subgroups learned the required responses in the training series equally well and made equally few errors (cf. Functionals

in Condition 2). Analysis of variance of frequency of errors over three blocks of fifteen training trials indicated that a highly significant reduction in errors occurred as training progressed ($F = 12.742$, $p < .0005$). Significant correlations were found between mean response latencies to the last block of fifteen training trials and to the test series for each of the four subgroups (Pearson correlation coefficients of +.69, +.64, and +.58, +.93 for the two organic and the two functional psychiatric subgroups respectively). Anxiety, which has been reported (Mayer and Coons, 1960) to have significant inhibiting effects on frequency of aftereffect report on the part of brain-injured patients seems to have decreased significantly during the training series. Only four of thirty-six brain damaged Ss from whom GSR records were obtained showed increases in anxiety as the training series progressed (Table 9).

The low incidence of SAE reports on the part of the Organic group under "delay" conditions supported the hypothesis that they would experience weaker or less vivid afterimages than Organics under "immediate" conditions. The similarity of the Organics and the Functionals in Condition 2 ("delay") in terms of frequency of aftereffect report may suggest further, that changes in the vividness or alternatively, rate of decay, of the aftereffect for

both groups may have been similar. However, the results obtained on response latencies (table 4) failed to confirm the prediction that Ss in Condition 2 would show longer reaction time to the test series than Ss in Condition 1. This finding tends to cast some doubt on the tenability of the hypothesis that the SAE would be significantly less vivid following a ten second delay than under "immediate" conditions. The lack of differences between subgroups in response latencies to the test series can only be partly accounted for on the basis of a set for quickly responding induced by the instructions administered by the experimenter. In addition only low rank correlations were found (table 5) between response latencies and frequency of aftereffect report for Ss in Condition 2.

The results obtained on the duration of the SAE in this study (tables 6, 7 and 8) indicated that brain damaged Ss did not differ significantly from comparable functional psychiatric Ss on this variable. These findings were in agreement with those reported by Page, et al., (1957), and in partial agreement with Schein's (1960), but contradicted those reported by Spivack and Levine (1957). The inconsistency with the results reported by the latter investigators may be due in large measure to sampling differences. The Spivack and Levine (1957) study sampled adolescents whereas in this

study adult brain-injured patients ranging in age from 28.1 years to 75.0 years were used. Though the Ss in Schein's (1960) investigation were adults they were examined within five days of their admission to hospital whereas in this study the Ss had been hospitalized for an average of 6.5 years prior to examination.

Another limitation of the present study was that the duration estimates were made on only two of the test trials. Reliability of the measures so obtained may be questionable. In addition the method used for estimates of duration of the SAE, though similar to that used by other investigators, may have been of dubious value. A stopwatch was used and Ss were simply told after they gave responses indicating perception of the SAE on either of the last two test trials to keep looking at the post-fixation balloon-spiral and tell the experimenter when it had stopped "getting bigger" or "getting smaller". Since none of the Ss had pretraining on this kind of task, as they did for reporting the presence or absence of the SAE, interpretations of the findings on duration of the SAE were limited by difficulties relating to the acceptability of verbal reports as valid indicators of the cessation of apparent movement.

V. Summary

Forty brain damaged mental hospital patients and forty non-organic psychiatric patients matched on age, sex, and length of hospitalization were tested with the Archimedes spiral in the context of a technique which sought to minimize possible confusion about the task, anxiety, and apprehension. In addition the vividness of the spiral aftereffect (SAE) for twenty of the brain damaged Ss and twenty of the non-organic psychiatric Ss was explored under delayed response conditions following fixation of the rotating spiral. Estimates of the duration of the SAE were also made on two of the test trials.

The results confirmed the expectation that brain-damaged patients would report perception of the SAE as frequently as a control group of comparable non-organic psychiatric patients. Neither age, length of hospitalization, nor visual acuity significantly differentiated any of the subgroups in terms of frequency of SAE report. None of the subgroups differed significantly in terms of duration of the SAE.

It was concluded that the results supported the contention of those investigators who have argued that

the characteristic failure of brain-injured patients to report the SAE may not necessarily indicate failure to experience the phenomenon. In addition it was suggested that theorizing in neurophysiological terms about the presumed failure of brain-injured patients to perceive the SAE was premature and that caution should be exercised in making inferences on the basis of their verbal reports. The findings on duration of the SAE were discussed in relation to those reported by other investigators.

In view of the findings of this investigation some research might be directed towards an examination of the precise nature of the psychological variables which seem to play an important role in the performance of brain-injured patients on the Archimedes spiral. For example, the roles of anxiety and the amount of information available to the patients about the task appear to be obscure at present. It may be that brain-injured patients need considerably more information or cues than other types of patients in order to function adequately on the Archimedes spiral test. Alternatively, amount of information may be unimportant when anxiety is minimal. Conceivably, such an inquiry could also explore the relationships of these variables to performance on a number of other perceptual tasks such as critical-flicker-fusion and visual figural-aftereffects.

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Appendices

Table 1 2

Appendix 1

The Age and Length of Hospitalization of Ss in Experimental Condition 1

Subject	Organic		Functional	
	Age	Hospitalization	Age	Hospitalization
Pair	in years	in months	in years	in months
1	54.7	175	59.0	167
2	60.7	162	55.0	174
3	54.3	190	56.0	191
4	59.6	43	59.8	31
5	61.8	63	56.6	54
6	31.8	55	37.3	64
7	67.3	81	67.6	91
8	56.9	29	57.0	34
9	59.3	105	55.3	111
10	59.8	112	53.0	123
11	75.0	13	78.3	102
12	62.7	81	63.6	101
13	43.0	66	40.3	73
14	51.2	46	56.3	37
15	43.8	190	41.8	187
16	59.5	21	60.6	23
17	37.3	121	37.8	114
18	57.0	11	54.3	14
19	34.0	31	39.5	19
20	40.1	1	32.8	2

Table 13

Appendix 2

The Age and Length of Hospitalization
of Ss in Experimental Condition 2

Subject	Organic		Functional	
	Age	Hospitalization	Age	Hospitalization
Pair	in years	in months	in years	in months
21	36.7	42	38.7	52
22	60.1	220	64.0	241
23	57.0	149	55.4	121
24	59.2	68	51.9	54
25	53.6	74	46.1	85
26	28.1	64	27.1	64
27	46.9	14	40.5	101
28	46.4	27	48.3	10
29	69.0	349	70.0	396
30	47.3	23	42.8	29
31	47.0	12	43.5	34
32	60.0	121	58.6	115
33	45.6	24	50.1	35
34	62.1	7	60.9	37
35	57.8	55	61.5	119
36	35.2	42	37.3	50
37	62.8	2	63.1	6
38	53.3	22	61.0	28
39	48.1	2	49.1	4
40	55.0	4	53.3	4

Table 14
Appendix

Frequency of Correct Report of the Expanding Aftereffect (EAE) and the Contracting Aftereffect (CAE)

Brain-Injured Ss			Functional Psychiatric Ss		
S. No.	EAE	CAE	S. No.	EAE	CAE
1	4	4	1	4	4
2	4	4	2	4	1
3	5	2	3	5	3
4	3	4	4	4	4
5	3	5	5	3	2
6	4	4	6	4	4
7	3	0	7	5	3
8	2	1	8	4	3
9	4	4	9	4	3
10	3	3	10	3	5
11	1	0	11	3	4
12	5	3	12	4	2
13	4	4	13	4	4
14	1	2	14	2	4
15	4	2	15	4	1
16	4	4	16	4	4
17	5	2	17	5	3
18	3	4	18	2	4
19	0	3	19	4	4
20	4	4	20	4	4
21	4	4	21	4	4
22	0	2	22	3	0
23	3	5	23	1	0
24	4	3	24	4	2
25	4	0	25	2	3
26	2	2	26	4	4
27	2	1	27	3	1
28	2	2	28	0	1
29	0	2	29	4	4
30	5	3	30	1	0
31	5	3	31	5	0
32	0	3	32	3	2
33	3	4	33	4	3
34	4	1	34	4	4
35	4	2	35	4	1
36	4	1	36	3	3
37	0	0	37	0	2
38	5	1	38	5	1
39	2	0	39	4	2
40	4	4	40	2	0

Table 15

Appendix

Duration of the Expanding Aftereffect (EAE)
and the Contracting Aftereffect (CAE)
in Seconds

Brain-Injured Ss			Functional Psychiatric Ss		
S. No.	EAE	CAE	S. No.	EAE	CAE
1	25	17	1	11	10
2	14	17	2	20	--
3	16	13	3	9	10
4	13	16	4	13	21
5	9	8	5	13	8
6	11	13	6	12	19
7	--	--	7	17	52
8	13	--	8	16	16
9	42	43	9	17	20
10	14	15	10	19	18
11	--	--	11	11	9
12	19	11	12	--	20
13	13	11	13	13	10
14	--	--	14	24	15
15	43	44	15	16	--
16	13	11	16	9	8
17	18	--	17	10	11
18	16	11	18	20	--
19	--	18	19	16	13
20	16	15	20	13	8
21	33	21	21	17	21
22	--	--	22	--	--
23	55	48	23	--	--
24	30	33	24	19	17
25	22	--	25	--	22
26	--	--	26	21	21
27	17	--	27	16	--
28	23	--	28	--	--
29	--	--	29	21	27
30	19	15	30	--	--
31	21	20	31	19	--
32	--	19	32	22	--
33	--	22	33	19	25
34	15	--	34	16	16
35	22	25	35	19	--
36	17	--	36	18	16
37	--	--	37	--	--
38	43	--	38	22	20
39	18	--	39	16	18
40	19	18	40	--	--

Table 16
Appendix

GSRs on Training Series and First Test Trial of Brain Damaged Ss

S No.	GSR Score on Trial Number					Mean GSR	GSR Score on Trial Number					Mean GSR	First Test Trial GSR
	1	2	3	4	5		41	42	43	44	45		
1	44	44	27	10	28	30.6	47	13	50	20	50	36.0	---
2	30	37	38	36	42	36.6	57	53	49	55	50	52.8	52
3	22	22	22	24	28	23.6	35	34	33	30	34	33.2	36
4	44	43	39	40	46	42.4	45	42	41	45	43	43.2	43
5	38	30	34	36	34	34.4	36	47	37	40	39	39.8	39
6	30	34	35	30	33	32.4	33	29	26	28	32	29.6	30
7		no record S unable to permit placement of electrodes											
8		no record (ran out of chart paper)											
9	32	30	28	36	43	33.8	48	25	46	42	45	41.2	45
10	40	40	37	44	38	39.8	48	51	48	48	48	48.6	51
11	30	33	31	30	30	30.8	37	34	34	39	40	36.8	36
12	31	33	25	32	30	30.2	40	35	39	38	35	37.4	34
13	22	23	26	26	31	25.6	36	35	33	35	35	34.8	33
14	24	26	29	31	33	28.6	40	40	40	37	40	39.4	39
15	57	40	42	20	40	39.8	44	42	0	32	55	34.6	54
16	32	35	36	36	34	34.6	38	42	41	40	40	40.2	41
17	36	36	38	38	39	37.4	40	38	40	41	40	39.8	39
18	34	36	37	33	38	35.6	44	38	39	38	37	39.2	30
19	40	29	35	33	42	35.8	41	44	36	44	38	40.6	40
20	33	36	36	37	38	36.0	42	40	40	41	40	40.6	40
21	12	34	20	43	27	27.2	18	26	12	16	44	23.2	---
22	35	16	26	34	38	29.8	33	47	32	54	37	40.6	---
23	56	48	52	0	10	33.2	34	57	24	44	18	35.4	---
24	32	34	30	34	32	32.4	36	31	30	28	28	30.6	43
25	36	31	35	36	39	35.4	36	34	38	45	48	40.2	40
26	19	19	18	19	19	18.8	18	19	20	20	18	19.0	20
27		no record. S refused to allow placement of electrodes											
28	44	46	24	29	31	34.8	52	51	51	46	51	50.2	50
29	56	59	59	56	59	57.8	64	64	63	64	60	63.0	64
30	36	39	40	42	41	39.6	46	49	48	48	48	47.8	44
31	15	24	18	33	14	20.8	36	34	40	30	40	36.0	37
32	33	37	34	39	38	36.2	39	38	40	42	40	39.8	40
33	28	31	32	34	34	31.8	39	40	39	40	39	39.4	40
34	36	36	35	38	38	36.6	41	40	41	42	42	41.2	42
35	34	38	38	36	40	37.2	42	38	36	43	43	40.4	40
36	62	65	64	64	70	65.0	72	72	73	74	90	76.2	78
37	25	32	38	35	33	32.6	44	38	32	32	38	36.8	31
38	55	55	58	58	60	57.2	58	62	63	64	64	62.2	64
39		no record (events-recorder failed to operate)											
40	31	33	35	35	35	33.8	34	38	32	36	38	35.6	38

Table 17
Appendix

Galvanic Skin Responses
of Brain-Injured Ss

S. No.	$\overline{M}$ GSR on first 5 training trials (A)	$\overline{M}$ GSR on last 5 training trials (B)	GSR on first test trial (C)	Sign Changes (A - B)	Sign Changes (A - C)	Sign Changes (B - C)
1	31	36	---	---		
2	37	53	52	---	---	+
3	24	33	36	---	---	---
4	42	43	43	---	---	±
5	34	40	39	---	---	+
6	32	30	30	+	+	±
7	no record - S unable to permit placement of electrodes					
8	no record					
9	34	41	45	---	---	---
10	40	49	51	---	---	---
11	31	37	36	---	---	+
12	30	37	34	---	---	+
13	26	35	33	---	---	+
14	29	39	39	---	---	±
15	40	35	54	+	---	---
16	35	40	41	---	---	---
17	37	40	39	---	---	+
18	36	39	30	---	+	+
19	36	41	40	---	---	+
20	36	41	40	---	---	+
21	27	23	--	+		
22	30	41	--	---		
23	33	35	--	---		
24	32	31	43	+	---	---
25	35	40	40	---	---	±
26	19	19	20	±	---	---
27	no record - S. refused to allow placement of electrodes.					
28	35	50	50	---	---	±
29	58	63	64	---	---	---
30	40	48	44	---	---	+
31	21	36	37	---	---	---
32	36	40	40	---	---	±
33	32	39	40	---	---	---
34	37	41	42	---	---	---
35	37	40	40	---	---	±
36	65	76	78	---	---	---
37	33	37	31	---	+	+
38	57	62	64	---	---	---
39	This S's record unusable.					
40	34	36	38	---	---	---
	Minus	Sign	Totals	31	29	14
			N =	35	32	25

Table 18

Appendix

GSRs on Training Series and First Test Trial of Functional Psychiatric Ss

S No.	GSR Score on Trial Number 1	2	3	4	5	Mean GSR	GSR Score on Trial Number 41	42	43	44	45	Mean GSR	First Test Trial GSR
1	14	31	20	34	22	24.2	22	36	32	29	27	29.2	26
2	37	34	34	30	34	33.8	34	38	35	41	36	36.8	44
3	18	26	18	24	32	23.6	35	38	28	32	28	32.2	33
4	5	7	5	8	7	6.4	10	6	9	7	7	7.8	4
5	44	45	46	40	48	44.6	49	50	49	49	50	49.4	50
6	34	33	36	36	40	35.8	41	42	40	41	41	41.0	38
7	58	63	63	64	64	62.4	69	67	64	70	70	68.0	67
8	47	43	41	48	46	45.0	50	48	46	46	45	47.0	38
9	34	40	40	44	42	40.0	46	45	46	47	47	46.2	43
10	21	20	28	24	36	25.8	36	35	35	35	36	35.4	38
11	28	31	32	32	33	31.2	33	37	35	38	38	36.2	34
12	38	39	31	34	37	35.8	37	45	41	42	40	41.0	30
13	17	24	10	32	19	20.4	29	27	34	38	36	32.8	32
14	28	30	32	36	37	32.6	44	41	43	42	48	43.6	36
15			no record										
16	26	32	32	28	29	29.4	40	30	34	27	37	33.6	30
17	32	36	34	36	36	34.8	44	50	52	54	50	50.0	35
18	37	8	42	8	39	26.8	40	34	42	20	41	35.4	0
19	21	18	18	20	27	20.8	33	27	23	25	22	26.0	18
20	31	35	35	35	34	34.0	40	40	39	39	40	39.6	40
21	28	27	17	20	20	22.4	17	35	7	17	14	18.0	17
22	36	37	35	44	40	38.4	41	44	32	42	44	40.6	40
23	35	31	38	31	36	34.2	42	40	39	37	40	39.6	42
24	17	28	9	25	29	21.6	36	33	30	27	33	31.8	31
25	35	39	36	39	38	37.4	44	44	42	36	39	41.0	40
26	48	54	56	53	53	52.8	58	58	56	60	60	58.4	52
27	40	36	36	37	40	37.8	55	56	51	56	56	54.8	56
28	20	34	32	30	30	29.2	36	42	32	38	35	36.6	41
29	26	30	30	32	35	30.6	40	40	40	35	41	39.2	40
30	23	25	31	32	32	28.6	37	40	38	39	38	38.4	36
31	16	28	27	26	31	25.6	43	23	32	40	34	34.4	41
32		no record			S would not allow placement of electrodes								
33	43	44	42	40	42	42.2	44	23	32	32	34	33.0	40
34	22	26	28	25	24	25.0	34	32	24	30	36	31.2	20
35	34	35	43	27	20	31.8	45	44	47	50	48	46.8	45
36	28	30	36	31	32	31.4	34	40	40	40	33	37.4	37
37	27	31	31	32	34	31.0	39	38	37	41	38	38.6	40
38	25	21	22	43	36	29.4	29	46	44	40	34	38.6	28
39	35	35	34	36	34	34.8	42	39	42	39	39	40.2	40
40	32	34	22	26	33	29.4	38	32	24	36	28	31.6	29

Table 19
Appendix

Galvanic Skin Responses
of Functional Ss.

S. No.	$\bar{M}$ GSR on first 5 training trials (A)	$\bar{M}$ GSR on last 5 training trials (B)	GSR on first test trial (C)	Sign Changes (A - B)	Sign Changes (A - C)	Sign Changes (B - C)
1	24	29	26	---	---	+
2	34	37	44	---	---	---
3	24	32	33	---	---	---
4	6	8	4	---	+	+
5	45	49	50	---	---	---
6	36	41	38	---	---	+
7	62	68	67	---	---	+
8	45	47	38	---	+	+
9	40	46	43	---	---	+
10	26	35	38	---	---	---
11	31	36	34	---	---	+
12	36	41	30	---	+	+
13	20	33	32	---	---	+
14	33	44	36	---	---	+
15	no record					
16	29	34	30	---	---	+
17	35	50	35	---	±	+
18	27	35	0	---	+	+
19	21	26	18	---	+	+
20	34	40	40	---	---	±
21	22	18	17	+	+	+
22	38	41	40	---	---	+
23	34	40	42	---	---	---
24	22	32	31	---	---	+
25	37	41	40	---	---	+
26	53	58	52	---	+	+
27	38	55	56	---	---	---
28	29	37	41	---	---	---
29	31	39	40	---	---	---
30	29	38	36	---	---	+
31	26	34	41	---	---	---
32	no record.	Would not allow placement of electrodes.				
33	42	33	40	+	+	---
34	25	31	20	---	+	+
35	32	47	45	---	---	+
36	31	37	37	---	---	±
37	31	39	40	---	---	---
38	29	39	28	---	+	+
39	35	40	40	---	---	±
40	29	32	29	---	±	+
	Minus	Sign	Totals	36	26	11
			N =	38	36	35

Table 20

Appendix

Training Errors of Ss by Successive Blocks of Fifteen Trials

S.	First Block		Second Block		Last Block	
Pair	Organic	Functional	Organic	Functional	Organic	Functional
1	2	0	5	0	4	1
2	6	3	0	1	0	4
3	1	6	0	2	0	3
4	2	3	5	4	0	2
5	5	5	5	0	7	2
6	3	4	0	4	1	2
7	4	5	2	5	3	5
8	5	4	2	1	3	0
9	4	0	2	0	2	0
10	1	2	0	0	0	0
11	3	9	1	6	0	4
12	6	4	2	7	1	8
13	2	0	2	0	3	0
14	0	3	3	2	1	3
15	9	1	5	0	4	0
16	1	3	0	1	1	0
17	3	2	1	0	0	0
18	3	7	0	1	0	3
19	4	2	5	0	4	0
20	0	2	0	3	0	2
21	4	2	0	1	1	0
22	5	4	1	7	0	7
23	4	0	5	0	3	0
24	6	2	3	0	1	0
25	9	4	9	4	7	2
26	4	3	1	0	0	0
27	4	8	2	2	1	1
28	0	0	0	1	0	0
29	6	5	8	2	9	4
30	1	4	0	1	0	1
31	1	4	1	4	0	2
32	3	0	4	0	4	0
33	5	4	3	2	3	0
34	0	2	0	1	0	0
35	2	1	3	1	0	0
36	3	3	2	0	3	0
37	7	0	0	0	0	0
38	5	4	5	0	2	0
39	6	4	9	1	4	1
40	4	0	3	0	0	0

Table 21

Appendix

Wilcoxon Matched-pairs Signed Ranks Test for Subjects
in Experimental "Condition 1" (on Test Performance)

Pair	Organic SAE Score	Functional SAE Score	d	Rank of d	Rank with less frequent sign
1	8	8	0		
2	8	5	3	10.0	10.0
3	7	8	- 1	- 3.5	
4	7	8	- 1	- 3.5	
5	8	5	3	10.0	10.0
6	8	8	0		
7	3	8	- 5	-13.5	
8	3	7	- 4	-12.0	
9	8	7	1	3.5	3.5
10	6	8	- 2	- 7.5	
11	1	7	- 6	-15.0	
12	8	6	2	7.5	7.5
13	8	8	0		
14	3	6	- 3	-10.0	
15	6	5	1	3.5	3.5
16	8	8	0		
17	7	8	- 1	- 3.5	
18	7	6	1	3.5	3.5
19	3	8	- 5	-13.5	
20	8	8	0		

N = 15

T = 38

For T = 38 and N = 15, "p" is N.S.

* Seigel, S., Nonparametric Statistics, McGraw-Hill, N.Y., 75-80, (1956)

Table 22

Appendix

Wilcoxon Matched-pairs Signed-Ranks Test for Subjects in Experimental "Condition 2" (on Test Performance)

Pair	Organic SAE Score	Functional SAE Score	d	Rank of d	Rank with less frequent sign
21	8	8	0		
22	2	3	- 1	- 3.5	
23	8	1	7	16.5	16.5
24	7	6	1	3.5	3.5
25	4	5	- 1	- 3.5	
26	4	8	- 4	-12.5	
27	3	4	- 1	- 3.5	
28	4	1	3	10.0	10.0
29	2	8	- 6	-14.5	
30	8	1	7	16.5	16.5
31	8	5	3	10.0	10.0
32	3	5	- 2	- 7.5	
33	7	7	0		
34	5	8	- 3	-10.0	
35	6	5	1	3.5	3.5
36	5	6	- 1	- 3.5	
37	0	2	- 2	- 7.5	
38	6	6	0		
39	2	6	- 4	-12.5	
40	8	2	6	14.5	14.5

N = 17

T = 74.5

For T = 74.5 and N = 17; "p" is N.S.

Siegel, S., Nonparametric Statistics, McGraw-Hill, N.Y., 75-80(1956)

Table 23

Appendix

Significance of the Difference Between the SAE scores (Test performance) of "Organics" in "Condition 1" and "Organics" in "Condition 2" (Mann-Whitney U test, normal approximation, corrected for ties)

S No.	Organic SAE Score "Condition 1"	Rank	S No.	Organic SAE Score "Condition 2"	Rank
1	8	33.5	21	8	33.5
2	8	33.5	23	8	33.5
5	8	33.5	30	8	33.5
6	8	33.5	31	8	33.5
9	8	33.5	40	8	33.5
12	8	33.5	24	7	23.5
13	8	33.5	33	7	23.5
16	8	33.5	35	6	18.5
20	8	33.5	38	6	18.5
3	7	23.5	34	5	15.5
4	7	23.5	36	5	15.5
17	7	23.5	25	4	13.0
18	7	23.5	26	4	13.0
10	6	18.5	28	4	13.0
15	6	18.5	27	3	8.5
7	3	8.5	32	3	8.5
8	3	8.5	22	2	4.0
14	3	8.5	29	2	4.0
19	3	8.5	39	2	4.0
11	1	2.0	37	0	1.0
R_1 =		468.5	R_2 =		351.5

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1 = 141.5$$

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\left[\frac{n_1 n_2}{N (N-1)}\right] \left[\frac{N^3 - N}{12} - \Sigma T\right]}}$$

$$z = \frac{141.5 - \frac{20 \times 20}{2}}{\sqrt{\left[\frac{20 \times 20}{40 (40-1)}\right] \left[\frac{40^3 - 40}{12} - 272\right]}} = 1.625$$

"p" = .0516 (one-tailed)

Table 24

Appendix

Significance of the Difference Between
the SAE Scores (Test performance) of "Functionals"
in "Condition 1" and "Functionals" in "Condition 2"
(Mann-Whitney U Test, normal approximation, corrected for ties)

S No.	Organic SAE Score "Condition 1"	Rank	S No.	Organic SAE Score "Condition 2"	Rank
1	8	33.0	21	8	33.0
3	8	33.0	26	8	33.0
4	8	33.0	29	8	33.0
6	8	33.0	34	8	33.0
7	8	33.0	33	7	23.5
10	8	33.0	24	6	18.0
13	8	33.0	36	6	18.0
16	8	33.0	38	6	18.0
17	8	33.0	39	6	18.0
19	8	33.0	25	5	11.0
20	8	33.0	31	5	11.0
8	7	23.5	32	5	11.0
9	7	23.5	35	5	11.0
11	7	23.5	27	4	7.0
12	6	18.0	22	3	6.0
14	6	18.0	37	2	4.5
18	6	18.0	40	2	4.5
2	5	11.0	23	1	2.0
5	5	11.0	28	1	2.0
15	5	11.0	30	1	2.0
R_1 =		520.5	R_2 =		

$$U = 20 \times 20 + \frac{20\ (21)}{2} - 520.5 = 89.5$$

$$z = \frac{U - \frac{n_1\ n_2}{2}}{\sqrt{\left[\frac{(n_1)\ (n_2)}{N\ (N-1)}\right]\left[\frac{N^3 - N}{12} - \Sigma T\right]}}$$

$$Z = \frac{89.5 - \frac{20 \times 20}{2}}{\sqrt{\left[\frac{20 \times 20}{40\ (40-1)}\right]\left[\frac{40^3 - 40}{12} - 343.5\right]}} = -3.09$$

"p" < .001

Table 25

Appendix

Wilcoxon Matched-pairs Signed Ranks Test for Training Errors of "Organics" and "Functionals"

Pair	"Organic" Training Errors	"Functional" Training Errors	d	Rank of d	Rank with less frequent sign
1	11	1	10	29.5	
2	6	8	- 2	- 5.5	5.5
3	1	11	-10	-29.5	29.5
4	7	9	- 2	- 5.5	5.5
5	17	7	10	29.5	
6	4	10	- 6	-17.5	17.5
7	9	15	- 6	-17.5	17.5
8	10	5	5	14.5	
9	8	0	8	25.0	
10	1	2	- 1	- 1.5	1.5
11	4	19	-15	-38.5	38.5
12	9	19	-10	-29.5	29.5
13	7	0	7	20.5	
14	4	8	- 4	-11.5	11.5
15	18	1	17	40.0	
16	2	4	- 2	- 5.5	5.5
17	4	2	2	5.5	
18	3	11	- 8	-25.0	25.0
19	13	2	11	32.5	
20	0	7	- 7	-20.5	20.5
21	5	3	2	5.5	
22	6	18	-12	-35.0	35.0
23	12	0	12	35.0	
24	10	2	8	25.0	
25	25	10	15	38.5	
26	5	3	2	5.5	
27	7	11	- 4	-11.5	11.5
28	0	1	- 1	- 1.5	1.5
29	23	11	12	35.0	
30	1	6	- 5	-14.5	14.5
31	2	10	- 8	-25.0	25.0
32	11	0	11	32.5	
33	11	6	5	14.5	
34	0	3	- 3	- 9.5	9.5
35	5	2	3	9.5	
36	8	3	5	14.5	
37	7	0	7	20.5	
38	12	4	8	25.0	
39	19	6	13	37.0	
40	7	0	7	20.5	

Siegel, Nonparametric Statistics, McGraw-Hill, N.Y., 75-80, 1956.

N = 40 T = 304.5 with N = 40 and T = 304.5 "p" is N.S.

Calculations:

$$Z = \frac{304.5 - \frac{40(41)}{4}}{\sqrt{\frac{40(41)(81)}{24}}}$$

Z = 1.42, "p" (2-tailed) = .1556 = N.S.

Table 26

Appendix

Pearson r Between Mean Latency on the last 15 training trials and the Mean Latency on the Test Series of all Ss in "Condition 1" (N=40)

	Organics			Functionals	
S. No.	MRT on last 15 Training Trials	MRT on Test Series	S. No.	MRT on last 15 Training Trials	MRT on Test Series
1	1.71	2.34	1	1.42	.19
2	.46	.25	2	2.42	4.22
3	1.09	.95	3	1.62	.51
4	1.37	1.52	4	.75	.11
5	.37	.16	5	4.25	2.03
6	1.19	.48	6	1.43	.38
7	5.00	7.83	7	.83	.50
8	2.31	5.01	8	1.63	1.55
9	3.42	.91	9	1.87	2.68
10	.68	1.30	10	2.61	2.37
11	2.23	6.66	11	.99	.50
12	2.25	2.66	12	3.44	5.05
13	.40	.53	13	1.70	1.01
14	.54	.77	14	.39	3.18
15	3.13	2.06	15	.77	2.37
16	1.09	1.12	16	.42	.18
17	1.67	1.59	17	.77	.75
18	1.47	2.00	18	1.60	1.08
19	4.15	2.86	19	.63	.45
20	1.02	1.28	20	.30	.16
21	.67	.33	21	.54	.18
22	1.02	3.01	22	5.44	10.75
23	5.12	3.26	23	1.02	1.71
24	2.42	2.38	24	.79	.50
25	2.44	3.33	25	.87	.77
26	.45	.87	26	1.01	.18
27	.75	1.25	27	.98	.92
28	1.35	3.59	28	.80	1.25
29	.80	.59	29	1.15	1.52
30	.43	1.67	30	.33	.45
31	.69	.86	31	.55	.31
32	2.87	2.57	32	1.57	3.37
33	.45	.91	33	1.57	1.72
34	.95	.77	34	.35	.10
35	3.47	3.58	35	.42	.85
36	1.01	1.33	36	.63	1.10
37	.85	1.66	37	.77	1.98
38	1.92	2.32	38	2.01	.55
39	.94	2.63	39	.62	.65
40	2.08	.81	40	.79	1.60

Table 27

Appendix

Spearman r Between RTs and SAE Scores
for Organics Condition 1

S. No.	RT	SAE	RT(RK)	SAE(RK)	d_i	d_i^2
7.	7.83	3	1	3.5	2.5	
11.	6.66	1	2	1	1.	
8.	5.01	3	3	3.5	.5	
19.	2.86	3	4	3.5	.5	
12.	2.66	8	5	16.	11.	
1.	2.34	8	6	16.	10.	
15.	2.06	6	7	6.5	.5	
18.	2.00	7	8	9.5	1.5	
17.	1.59	7	9	9.5	.5	
4.	1.52	7	10	9.5	.5	
10.	1.30	6	11	6.5	4.5	
20.	1.28	8	12	16.	4.	
16.	1.12	8	13	16.	3.	
3.	.95	7	14	9.5	4.5	
9.	.91	8	15	16.	1.	
14.	.77	3	16	3.5	12.5	
13.	.53	8	17	16.	1.	
6.	.48	8	18	16.	2.	
2.	.25	8	19	16.	3.	
5.	.16	8	20	16.	4.	

$$\Sigma X^2 = \frac{N^3 - N}{12} - \Sigma T_x \qquad \Sigma Y^2 = \frac{N^3 - N}{12} - \Sigma T_y \qquad \Sigma d_i^2 = 484.5$$

$$\Sigma X^2 = 665 - 0 = 665 \qquad \Sigma Y^2 = 665 - 70.5 = 594.5$$

$$r_s = \frac{\Sigma X^2 + \Sigma Y^2 - \Sigma d^2}{2\sqrt{\Sigma X^2 \ \Sigma Y^2}} = \frac{665 + 594.5 - 484.5}{2\sqrt{665 \times 594.5}}$$

$= 0.616$ $\qquad p < .01$ (from Table)

Table 28

Appendix

Spearman r Between RTs and SAE Scores for Organics in Condition 2

S. No.	RT	SAE	RT(RK)	SAE(RK)	d_i	d_i^2
28.	3.59	4	1	8.	7.	
35.	3.58	6	2	12.5	10.5	
25.	3.33	4	3	8.	5.	
23.	3.26	8	4	18.	14.	
22.	3.01	2	5	3	2.	
39.	2.63	2	6	3	3.	
32.	2.57	3	7	5.5	1.5	
24.	2.38	7	8	14.5	6.5	
38.	2.32	6	9	12.5	3.5	
30.	1.67	8	10	18.0	8.0	
37.	1.66	0	11	1.0	10.0	
36.	1.33	5	12	10.5	1.5	
27.	1.25	3	13	5.5	7.5	
33.	.91	7	14	14.5	.5	
26.	.87	4	15	8.0	7.0	
31.	.86	8	16	18.0	2.0	
40.	.81	8	17	18.0	1.0	
34.	.77	5	18	10.5	7.5	
29.	.59	2	19	3	16.	
21.	.33	8	20	18.0	2.0	

$\Sigma d_i^2 = 1043$

$$\Sigma X^2 = \frac{N^3 - N}{12} - \Sigma T_x \qquad \Sigma Y^2 = \frac{N^3 - N}{12} - \Sigma T_y$$

$$= 665 \qquad = 665 - 16 = 649$$

$$r_s = \frac{\Sigma X^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma X^2 \ \Sigma y^2}} = \frac{665 + 649 - 1043}{2\sqrt{665 \times 649}}$$

$$= \frac{271}{2 \times 756.947} = \frac{271}{1513.894} = 0.179 \qquad p = \text{n.s.}$$

Table 29

Appendix

Spearman r Between RT and SAE Scores
for Functionals in Condition 1

S. No.	RT	SAE	RT(RK)	SAE(RK)	d_i	d_i^2
12	5.05	6	1	5.	4.	
2	4.22	5	2	2.	0.	
14	3.18	6	3	5.	2.	
9	2.68	7	4	8.	4.	
10	2.37	8	5.5	15.	9.5	
15	2.37	5	5.5	2.	3.5	
5	2.03	5	7.	2.	5.	
8	1.55	7	8.	8.	0.	
18	1.08	6	9.	5.	4.	
13	1.01	8	10.	15.	5.	
17	.75	8	11.	15.	4.	
3	.51	8	12.	15.	3.	
7	.50	8	13.5	15.	1.5	
11	.50	7	13.5	8.	5.5	
19	.45	8	15.	15.	0.	
6	.38	8	16	15.	1.	
1	.19	8	17	15.	2.	
16	.18	8	18	15.	3.	
20	.16	8	19	15.	4.	
4	.11	8	20	15.	5.	

$$\Sigma d^2 = 317$$

$$\Sigma X^2 = \frac{N^3 - N}{12} - \Sigma Tx \qquad \Sigma Y^2 = \frac{N^3 - N}{12} - \Sigma Ty$$

$$= 665 - 1 = 664 \qquad = 665 - 116 = 549$$

$$r_s = \frac{\Sigma X^2 + \Sigma Y^2 - \Sigma d^2}{2\sqrt{\Sigma X^2 \; \Sigma Y^2}} = \frac{664 + 549 - 317}{2\sqrt{664 \times 549}} = \frac{896}{1207.530}$$

$$r_s = 0.742 \qquad p \leqslant .01$$

Table 30

Appendix

Spearman r Between RTs and SAE Scores
For Functionals in Condition 2

S. No.	RT	SAE	RT(RK)	SAE(RK)	d_i	d_i^2
22	10.75	3	1	6.	5.	
32	3.37	5	2	9.5	7.5	
37	1.98	2	3	4.5	1.5	
33	1.72	7	4	16.	12.	
23	1.71	1	5	2.	3.	
40	1.60	2	6	4.5	1.5	
29	1.52	8	7	18.5	11.5	
28	1.25	1	8	2.	6.	
36	1.10	6	9	13.5	4.5	
27	.92	4	10	7.	3.	
35	.85	5	11	9.5	1.5	
25	.77	5	12	9.5	2.5	
39	.65	6	13	13.5	.5	
38	.55	6	14	13.5	.5	
24	.50	6	15	13.5	1.5	
30	.45	1	16	2.	14.	
31	.31	5	17	9.5	7.5	
26	.18	8	18.5	18.5	0	
21	.18	8	18.5	18.5	0	
34	.10	8	20.	18.5	1.5	

$\Sigma d^2 = 702$

$$\Sigma X^2 = \frac{N^3 - N}{12} - \Sigma Tx \qquad \Sigma Y^2 = \frac{N^3 - N}{12} - \Sigma Ty$$

$$= 665 - .5 = 664.5 \qquad = 665 - 17.5 = 647.5$$

$$r_s = \frac{\Sigma X^2 + \Sigma Y^2 - \Sigma d^2}{2\sqrt{\Sigma X^2 \ \Sigma Y^2}} = \frac{664.5 + 647.5 - 702}{2\sqrt{664.5 \times 647.5}}$$

$$= 0.465 \qquad P < .01$$

Table 31

Appendix

Spearman r between Mean Latency on Test Series
of all Ss (N=80) and SAE scores
(corrected for ties, normal approximation)

S No.	$\bar{M}$ RT in Seconds	SAE Score	RT Rank(X)	SAE Rank y	d_i	d_i^2
22	10.75	3	1	14.0	-13.0	
7.	7.83	3	2	14.0	-12.0	
11.	6.66	1	3	3.5	- .5	
12	5.05	6	4	36.0	-32.0	
8.	5.01	3	5	14.0	- 9.0	
2	4.22	5	6	26.0	-20.0	
28.	3.59	4	7	19.5	-12.5	
35.	3.58	6	8	36.0	-28.0	
32	3.37	5	9	26.0	-17.0	
25.	3.33	4	10	19.5	- 9.5	
23.	3.26	8	11	66.0	-55.0	
14	3.18	6	12	36.0	-24.0	
22.	3.01	2	13	8.0	5.0	
19.	2.86	3	14	14.0	0.0	
9	2.68	7	15	46.5	-31.5	
12.	2.66	8	16	66.0	-50.0	
39.	2.63	2	17	8.0	9.0	
32.	2.57	3	18	14.0	4.0	
24.	2.38	7	19	46.5	-27.5	
10	2.37	8	20.5	66.0	-45.5	
15	2.37	5	20.5	26.0	- 5.5	
10	2.34	8	22	66.0	-44.0	
38.	2.32	6	23	36.0	-13.0	
15.	2.06	6	24	36.0	-12.0	
5	2.03	5	25	26.0	- 1.0	
18.	2.00	7	26	46.5	-20.5	
37	1.98	2	27	8.0	19.0	
33	1.72	7	28	46.5	-18.5	
23	1.71	1	29	3.5	25.5	
30.	1.67	8	30	66.0	-36.0	
37.	1.66	0	31	1.0	30.0	
40	1.60	2	32	8.0	24.0	
17.	1.59	7	33	46.5	-13.5	
8	1.55	7	34	46.5	-12.5	
29	1.52	8	35.5	66.0	-30.5	
4.	1.52	7	35.5	46.5	-11.0	
36.	1.33	5	37	26.0	11.0	
10.	1.30	6	38	36.0	2.0	
20.	1.28	8	39	66.0	-27.0	
27.	1.25	3	40.5	14.0	26.5	
28	1.25	1	40.5	3.5	37.0	
16.	1.12	8	42	66.0	-24.0	
36	1.10	6	43	36.0	7.0	
18	1.08	6	44	36.0	8.0	
13	1.01	8	45	66.0	-21.0	
3.	.95	7	46	46.5	- .5	
27	.92	4	47	19.5	27.5	
33.	.91	7	48.5	46.5	2.0	
9.	.91	8	48.5	66.0	-17.5	

(2)

Spearman r between Mean Latency on Test Series etc.

S No.	$\overline{M}$ RT in Seconds	SAE Score	RT Rank(X)	SAE Rank y	d_i	d_i^2
26.	.87	4	50	19.5	30.5	
31.	.86	8	51	66.0	-15.0	
35	.85	5	52	26.0	26.0	
40.	.81	8	53	66.0	-13.0	
25	.77	5	55.0	26.0	29.0	
34.	.77	5	55.0	26.0	29.0	
14.	.77	3	55.0	14.0	41.0	
17	.75	8	57	66.0	- 9.0	
39	.65	6	58	36.0	22.0	
29.	.59	2	59	8.0	51.0	
38	.55	6	60	36.0	24.0	
13.	.53	8	61	66.0	- 5.0	
3	.51	8	62	66.0	- 4.0	
7	.50	8	64.0	66.0	- 2.0	
11	.50	7	64.0	46.5	17.5	
24	.50	6	64.0	36.0	28.0	
6.	.48	8	66	66.0	0.0	
19	.45	8	67.5	66.0	1.5	
30	.45	1	67.5	3.5	64.0	
6	.38	8	69	66.0	3.0	
21.	.33	8	70	66.0	4.0	
31	.31	5	71	26.0	5.0	
2.	.25	8	72	66.0	6.0	
1	.19	8	73	66.0	7.0	
16	.18	8	75.0	66.0	9.0	
26	.18	8	75.0	66.0	9.0	
21	.18	8	75.0	66.0	9.0	
20	.16	8	77.5	66.0	11.5	
5.	.16	8	77.5	66.0	11.5	
4	.11	8	79	66.0	13.0	
34	.10	8	80	66.0	14.0	

$\Sigma d^2 = 41,863.50$

$\Sigma x^2 = 42,660 - 9 \qquad \Sigma y^2 = 42,660 - 3220.5$

$$r_s = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma x^2 \, \Sigma y^2}} =$$

$$r_s = \frac{42,651 + 40,329.5 - 41,863.5}{2\sqrt{1720093504.5}} = \frac{41,117}{2 \times 41,474}$$

$r_s = .50$

where $t = r_s \sqrt{\dfrac{N - 2}{1 - r_s^2}} = 5.99$

"p" < .001 (2-tailed)

Table 32

Appendix

Significance of the Difference Between the Mean Latencies on the test series of "Organics" in "Condition 1" and "Organics" in "Condition 2"

S. No.	"Organic RT in Secs. Condition 1	S. No.	"Organic RT in Secs. Condition 2.
1	2.34	21	.33
2	.25	22	3.01
3	.95	23	3.26
4	1.52	24	2.38
5	.16	25	3.33
6	.48	26	.87
7	7.83	27	1.25
8	5.01	28	3.59
9	.91	29	.59
10	1.30	30	1.67
11	6.66	31	.86
12	2.66	32	2.57
13	.53	33	.91
14	.77	34	.77
15	2.06	35	3.58
16	1.12	36	1.33
17	1.59	37	1.66
18	2.00	38	2.32
19	2.86	39	2.63
20	1.28	40	.81

$N_x = 20$		$N_y = 20$
$\bar{X} = 2.11$		$\bar{Y} = 1.89$
$\Sigma X = 42.28$		$\Sigma Y = 37.72$
$\Sigma X^2 = 172.08$		$\Sigma Y^2 = 93.96$
$(\Sigma X)^2 = 1787.60$		$(\Sigma Y)^2 = 1422.80$

$$S^2 = \frac{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{N_x}\right] + \left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{N_y}\right]}{N_x + N_y - 2} = 2.78$$

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{S^2}{N_x} + \frac{S^2}{N_y}}} = .42$$

for $t = .42$ "p" is N.S.

Table 33

Appendix

Significance of the Difference Between
Mean Latencies on the Test Series of "Functionals"
in"Condition 1" and "Functionals" in "Condition 2"

S No.	Functional $\overline{M}$ RT in secs. Condition 1.	S No.	Functional $\overline{M}$ RT in secs. Condition 2.
1	.19	21	.18
2	4.22	22	10.75
3	.51	23	1.71
4	.11	24	.50
5	2.03	25	.77
6	.38	26	.18
7	.50	27	.92
8	1.55	28	1.25
9	2.68	29	1.52
10	2.37	30	.45
11	.50	31	.31
12	5.05	32	3.37
13	1.01	33	1.72
14	3.18	34	.10
15	2.37	35	.85
16	.18	36	1.10
17	.75	37	1.98
18	1.08	38	.55
19	.45	39	.65
20	.16	40	1.60

N_x =	20	Ny =	20
$\overline{X}$ =	1.46	$\overline{Y}$ =	1.52
ΣX =	29.27	ΣY =	30.46
ΣX^2 =	82.33	ΣY^2 =	147.88
$(\Sigma X)^2$ =	856.73	$(\Sigma Y)^2$ =	927.81

$$s^2 = \frac{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{Nx}\right] + \left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{Ny}\right]}{Nx + Ny - 2} = 3.71$$

$$t = \frac{\overline{X} - \overline{Y}}{\sqrt{\frac{s^2}{Nx} + \frac{s^2}{Ny}}} = .01$$

for t = .01 "p" is N.S.

Table 34

Appendix

Significance of the Difference Between
Mean Latencies on the test series of "Organics"
(N=40) and "Functionals" (N=40)

where Nx = Number of Organics Ss.

and Ny = Number of Functional Ss.

N_x	=	40	N_y	=	40
$\bar{X}$	=	2.00	$\bar{Y}$	=	1.49
ΣX	=	80.00	ΣY	=	59.73
ΣX^2	=	266.04	ΣY^2	=	230.21
$(\Sigma X)^2$	=	6400.00	$(\Sigma Y)^2$	=	3567.67

$$S^2 = \frac{\left[\Sigma X^2 - \frac{(\Sigma X)^2}{N_x}\right] + \left[\Sigma Y^2 - \frac{(\Sigma Y)^2}{N_y}\right]}{N_x + N_y - 2}$$

$$S^2 = 3.17$$

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{S^2}{N_x} + \frac{S^2}{N_y}}} = 1.28$$

for t = 1.28, "p" is N.S.

Table 35

Appendix

Significance of the Difference Between
Mean Visual Acuity Scores (Square-root tranformation $x = \sqrt{x+.5}$)
for "Organics" in "Condition 1" and "Organics" in "Condition 2"

"Organic" VA Scores "Condition 1" and "Condition 2"

S No.	"Organic" VA Transformed Score "Condition 1"	S No.	"Organic" VA transformed Score "Condition 2"
1	4.53	21	5.52
2	6.36	22	5.52
3	5.05	23	4.53
4	5.52	24	5.05
5	5.52	25	7.78
6	5.52	26	8.97
7	10.02	27	6.36
8	5.52	28	5.05
9	7.78	29	10.02
10	5.52	30	4.53
11	10.02	31	6.36
12	8.97	32	7.11
13	6.36	33	5.52
14	3.94	34	6.36
15	10.02	35	5.52
16	4.53	36	4.53
17	5.52	37	4.53
18	4.53	38	10.02
19	5.52	39	3.94
20	3.94	40	5.52

$N_x = 20$ $\qquad$ $N_y = 20$

$\bar{X} = 6.235$ $\qquad$ $\bar{Y} = 6.137$

$\Sigma X = 124.69$ $\qquad$ $\Sigma Y = 122.74$

$\Sigma X^2 = 854.495$ $\qquad$ $\Sigma Y^2 = 814.655$

$(\Sigma X)^2 = 15547.596$ $\qquad$ $(\Sigma Y)^2 = 15065.108$

$$S^2 = \frac{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{N_x}\right) + \left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{N_y}\right)}{Nx + Ny - 2} = 3.645$$

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{S^2}{10}}} = .162$$

"p" is N.S.

Table 36

Appendix

Significance of the Difference Between
Mean Visual Acuity Scores (Square-root transformation $x = \sqrt{x+.5}$)
for "Functionals" in "Condition 1" and "Functionals" in "Condition 2"

S No.	"Functional" VA Transformed Score "Condition 1"	S No.	"Functional" VA Transformed Score "Condition 2".
1	10.02	21	4.53
2	6.36	22	5.05
3	4.53	23	6.36
4	6.36	24	5.52
5	7.78	25	5.52
6	4.53	26	5.05
7	6.36	27	3.94
8	5.05	28	5.52
9	7.11	29	5.52
10	6.36	30	5.52
11	6.36	31	5.05
12	5.52	32	5.52
13	4.53	33	5.05
14	5.52	34	4.53
15	5.05	35	5.52
16	6.36	36	5.05
17	5.05	37	5.05
18	6.36	38	5.05
19	5.05	39	4.53
20	4.53	40	10.02

Nx	$= 20$	Nx	$= 20$
$\bar{X}$	$= 5.940$	$\bar{Y}$	$= 5.395$
ΣX	$= 118.79$	ΣY	$= 107.90$
ΣX^2	$= 739.663$	ΣY^2	$= 609.747$
$(\Sigma X)^2$	$= 14111.064$	$(\Sigma Y)^2$	$= 11642.410$

$$s^2 = \frac{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{Nx}\right) + \left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{Ny}\right)}{Nx + Ny - 2} = 1.625$$

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{s^2}{10}}} = \frac{.545}{\sqrt{\frac{1.625}{10}}} = 1.35$$

"p" is N.S.

Table 37

Appendix

Significance of the Difference Between Mean Visual Acuity Scores (Square - root transformation, $x = \sqrt{x+.5}$) for "Organics" and "Functionals" in both conditions

Where

$N_{\text{Organics}} = N_x = 40$

$N_{\text{Functionals}} = N_y = 40$

$\bar{X}$ = 6.186		$\bar{Y}$ = 5.668	
ΣX = 247.43		ΣY = 226.69	
ΣX^2 = 1669.150		ΣY^2 = 1349.41	
$(\Sigma X)^2$ = 61,221.605		$(\Sigma Y)^2$ = 51,388.356	

$$s^2 = \frac{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{Nx}\right) + \left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{Ny}\right)}{Nx + Ny - 2} = 2.607$$

$$t = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{S^2}{Nx} + \frac{S^2}{Ny}}} = \frac{.518}{\sqrt{2\left(\frac{2.607}{40}\right)}} = 1.435$$

"p" is N.S.

Table 38

Appendix

Spearman r of Age of all Ss in both experimental conditions and SAE scores (Corrected for ties)

S No.	Age	SAE Score	Age(X) Rank	SAE(Y) Rank	d_i	d_i^2
11	78.3	7	1	46.5	-45.5	
11.	75.0	1	2	3.5	- 1.5	
29	70.0	8	3	66.0	-63.0	
29.	69.0	2	4	8.0	- 4.0	
7	67.6	8	5	66.0	-61.0	
7.	67.3	3	6	14.0	- 8.0	
22	64.0	3	7	14.0	- 7.0	
12	63.6	6	8	36.0	-28.0	
37	63.1	2	9	8.0	1.0	
37.	62.8	0	10	1	9.0	
12.	62.7	8	11	66.0	-55.0	
34.	62.1	5	12	26.0	-14.0	
5.	61.8	8	13	66.0	-53.0	
35	61.5	5	14	26.0	-12.0	
38	61.0	6	15	36.0	-21.0	
34	60.9	8	16	66.0	-50.0	
2.	60.7	8	17	66.0	-49.0	
16	60.6	8	18	66.0	-48.0	
22.	60.1	2	19	8.0	11.0	
32.	60.0	3	20	14.0	6.0	
4	59.8	8	21.5	66.0	-44.5	
10.	59.8	6	21.5	36.0	-14.5	
4.	59.6	7	23	46.5	-23.5	
16.	59.5	8	24	66.0	-42.0	
9.	59.3	8	25	66.0	-41.0	
24.	59.2	7	26	46.5	-20.5	
1	59.0	8	27	66.0	-39.0	
32	58.6	5	28	26.0	2.0	
35.	57.8	6	29	36.0	- 7.0	
23.	57.0	8	31.0	66.0	-35.0	
18.	57.0	7	31.0	46.5	-15.5	
8	57.0	7	31.0	46.5	-15.5	
8.	56.9	3	33	14.0	19.0	
5	56.6	5	34	26.0	8.0	
14	56.3	6	35	36.0	- 1.0	
3	56.0	8	36	66.0	-30.0	
23	55.4	1	37	3.5	33.5	
9	55.3	7	38	46.5	- 8.5	
40.	55.0	8	39.5	66.0	-26.5	
2	55.0	5	39.5	26.0	13.5	
1.	54.7	8	41	66.0	-25.0	
18	54.3	6	42.5	36.0	6.5	
3.	54.3	7	42.5	46.5	- 4.0	
25.	53.6	4	44	19.5	24.5	
38.	53.3	6	45.5	36.0	9.5	
40	53.3	2	45.5	8.0	37.5	
10	53.0	8	47	66.0	-19.0	
24	51.9	6	48	36.0	12.0	
14.	51.2	3	49	14.0	35.0	

S. Nos. with "dot", e.g. "11.", indicates Organic S. No. 11.

S No.	Age	SAE Score	Age(X) Rank	SAE(Y) Rank	d_i	d_i^2
33	50.1	7	50	46.5	3.5	
39	49.1	6	51	36.0	15.0	
28	48.3	1	52	3.5	48.5	
39.	48.1	2	53	8.0	45.0	
30.	47.3	8	54	66.0	-12.0	
31.	47.0	8	55	66.0	-11.0	
27.	46.9	3	56	14.0	42.0	
28.	46.4	4	57	19.5	37.5	
25	46.1	5	58	26.0	32.0	
33.	45.6	7	59	46.5	12.5	
15.	43.8	6	60	36.0	24.0	
31	43.5	5	61	26.0	35.0	
13.	43.0	8	62	66.0	- 4.0	
30	42.8	1	63	3.5	59.5	
15	41.8	5	64	26.0	38.0	
27	40.5	4	65	19.5	45.5	
13	40.3	8	66	66.0	0.0	
20.	40.1	8	67	66.0	1.0	
19	39.5	8	68	66.0	2.0	
21	38.7	8	69	66.0	3.0	
17	37.8	8	70	66.0	4.0	
36	37.3	6	72.0	36.0	36.0	
6	37.3	8	72.0	66.0	6.0	
17.	37.3	7	72.0	46.5	25.5	
21.	36.7	8	74	66.0	8.0	
36.	35.2	5	75	26.0	49.0	
19.	34.0	3	76	14.0	62.0	
20	32.8	8	77	66.0	11.0	
6.	31.8	8	78	66.0	12.0	
26.	28.1	4	79	19.5	59.5	
26	27.1	8	80	66.0	14.0	

$\Sigma d_i^2 = 72961.00$

$$\Sigma x^2 = \frac{N^3 - N}{12} - \Sigma T_x = 42,660 - 6 = 42,654$$

$$\Sigma y^2 = \frac{N^3 - N}{12} - \Sigma T_y = 42,660 - 2330.5 = 40,329.5$$

$$r_s = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma x^2 \, \Sigma y^2}}$$

$$r_s = \frac{42,654 + 40,329.5 - 72,961}{2\sqrt{1,720,214,493.0}} = .121$$

for $r_s = .121$, and df = 78, $\underline{t} = 1.08$

$\underline{p}$ is N.S.

Table 39

Appendix

Spearman r for Length of Hospitalization of all Ss (N=80) and SAE scores (corrected for ties on both variables)

S No.	Ltg. Hosp. in Mos.	SAE Score	Hosp. Rank(X)	SAE Rank(Y)	d_i	d_i^2
29	396	8	1	66.0	-65.0	
29.	349	2	2	8.0	- 6.0	
22	241	3	3	14.0	-11.0	
22.	220	2	4	8.0	- 4.0	
3	191	8	5	66.0	-61.0	
3.	190	7	6.5	46.5	-40.0	
15.	190	6	6.5	36.0	-29.5	
15	187	5	8	26.0	-18.0	
1.	175	8	9	66.0	-57.0	
2	174	5	10	26.0	-16.0	
1	167	8	11	66.0	-55.0	
2.	162	8	12	66.0	-54.0	
23.	149	8	13	66.0	-53.0	
10	123	8	14	66.0	-52.0	
17.	121	7	16.0	46.5	-30.5	
23	121	1	16.0	3.5	12.5	
32.	121	3	16.0	14.0	2.0	
35	119	5	18	26.0	- 8.0	
32	115	5	19	26.0	- 7.0	
17	114	8	20	66.0	-46.0	
10.	112	6	21	36.0	-15.0	
9	111	7	22	46.5	-24.5	
9.	105	8	23	66.0	-43.0	
11	102	7	24	46.5	-22.5	
12	101	6	25.5	36.0	-10.5	
27	101	4	25.5	19.5	6.0	
7	91	8	27	66.0	-39.0	
25	85	5	28	26.0	2.0	
7.	81	3	29.5	14.0	15.5	
12.	81	8	29.5	66.0	-36.5	
25.	74	4	31	19.5	11.5	
13	73	8	32	66.0	-34.0	
24.	68	7	33	46.5	-13.5	
13.	66	8	34	66.0	-32.0	
6	64	8	36.0	66.0	-30.0	
26.	64	4	36.0	19.5	16.5	
26	64	8	36.0	66.0	-30.0	
5.	63	8	38	66.0	-28.0	
6.	55	8	39.5	66.0	-26.5	
35.	55	6	39.5	36.0	3.5	
5	54	5	41.5	26.0	15.5	
24	54	6	41.5	36.0	5.5	
21	52	8	43	66.0	-23.0	
36	50	6	44	36.0	8.0	
14.	46	3	45	14.0	31.0	
4.	43	7	46	46.5	- 0.5	
21.	42	8	47.5	66.0	-18.5	
36.	42	5	47.5	26.0	21.5	

S. Nos. with "dot", e.g. "29." indicates Organic S. No. 29.

S. Nos without dot "e.g.,"29" indicates Functional S. No. 29.

S No.	Ltg. Hosp. in Mos.	SAE Score	Hosp. Rank(X)	SAE Rank(Y)	d_i	d_i^2
14	37	6	49.5	36.0	13.5	
34	37	8	49.5	66.0	-16.5	
33	35	7	51	46.5	4.5	
8	34	7	52.5	46.5	6.0	
31	34	5	52.5	26.0	26.5	
4	31	8	54.5	66.0	-11.5	
19.	31	3	54.5	14.0	40.5	
30	29	1	56.5	3.5	53.0	
8.	29	3	56.5	14.0	42.5	
38	28	6	58	36.0	22.0	
28.	27	4	59	19.5	39.5	
33.	24	7	60	46.5	13.5	
16	23	8	61.5	66.0	- 4.5	
30.	23	8	61.5	66.0	- 4.5	
38.	22	6	63	36.0	27.0	
16.	21	8	64	66.0	- 2.0	
19	19	8	65	66.0	- 1.0	
18	14	6	66.5	36.0	30.5	
27.	14	3	66.5	14.0	52.5	
11.	13	1	68	3.5	64.5	
31.	12	8	69	66.0	3.0	
18.	11	7	70	46.5	23.5	
28	10	1	71	3.5	67.5	
34.	7	5	72	26.0	46.0	
37	6	2	73	8.0	65.0	
39	4	6	75.0	36.0	39.0	
40	4	2	75.0	8.0	67.0	
40.	4	8	75.0	66.0	9.0	
37.	2	0	78.0	1	77.0	
39.	2	2	78.0	8.0	70.0	
20	2	8	78.0	66.0	12.0	
20.	1	8	80	66.0	14.0	

$\Sigma d_i^2 = 91,477.5$

$\Sigma x^2 = \frac{N^3 - N}{12} - \Sigma Tx$ $\quad\quad$ $\Sigma y^2 = \frac{N^3 - N}{12} - \Sigma Ty$

$\Sigma x^2 = 42,646$ $\quad\quad$ $\Sigma y^2 - 40,329.5$

$$rs = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma x^2 \, \Sigma y^2}}$$

$rs = -.103$

for $rs = -.103$ and $df = 78$, $t = .915$, "p" is N.S.

Table 40

Appendix

Spearman r for Visual Acuity Scores
of all Ss (N=80) and SAE scores
(corrected for t ies on both variables)

S No.	VA Score	SAE Score	VA Rank(X)	SAE Rank(Y)	d_i	d_i^2
1	>80	8	4.0	66.0	-62.0	
7.	>80	3	4.0	14.0	-10.0	
11.	>80	1	4.0	3.5	0.5	
15.	>80	6	4.0	36.0	-32.0	
29.	>80	2	4.0	8.0	- 4.0	
38.	>80	6	4.0	36.0	-32.0	
40	>80	2	4.0	8.0	- 4.0	
12.	80	8	8.5	66.0	57.5	
26.	80	4	8.5	19.5	-11.0	
9.	60	8	11.0	66.0	-55.0	
25.	60	4	11.0	19.5	- 8.5	
5	60	5	11.0	26.0	-15.0	
32.	50	3	13.5	14.0	- 0.5	
9	50	7	13.5	46.5	-33.0	
2.	40	8	21.0	66.0	-45.0	
13.	40	8	21.0	66.0	-45.0	
27.	40	3	21.0	14.0	7.0	
31.	40	8	21.0	66.0	-45.0	
34.	40	5	21.0	26.0	- 5.0	
2	40	5	21.0	26.0	- 5.0	
4	40	8	21.0	66.0	-45.0	
7	40	8	21.0	66.0	-45.0	
10	40	8	21.0	66.0	-45.0	
11	40	7	21.0	46.5	-25.5	
16	40	8	21.0	66.0	-45.0	
18	40	6	21.0	36.0	-15.0	
23	40	1	21.0	3.5	17.5	
4.	30	7	38.0	46.5	- 8.5	
5.	30	8	38.0	66.0	-28.0	
6.	30	8	38.0	66.0	-28.0	
8.	30	3	38.0	14.0	24.0	
10.	30	6	38.0	36.0	2.0	
17.	30	7	38.0	46.5	- 8.5	
19.	30	3	38.0	14.0	24.0	
21.	30	8	38.0	66.0	-28.0	
22.	30	2	38.0	8.0	30.0	
33.	30	7	38.0	46.5	- 8.5	
35.	30	6	38.0	36.0	2.0	
40.	30	8	38.0	66.0	-28.0	
12	30	6	38.0	36.0	2.0	
14	30	6	38.0	36.0	2.0	
24	30	6	38.0	36.0	2.0	
25	30	5	38.0	26.0	12.0	
28	30	1	38.0	3.5	34.5	
29	30	8	38.0	66.0	-28.0	
30	30	1	38.0	3.5	34.5	
32	30	5	38.0	26.0	12.0	
35	30	5	38.0	26.0	12.0	
3.	25	7	55.5	46.5	9.0	
24.	25	7	55.5	46.5	9.0	

Spearman r for Visual Acuity Scores etc.

S No.	VA Score	SAE Score	VA Rank(X)	SAE Rank(Y)	d_i	d_i^2
28.	25	4	55.5	19.5	36.0	
8	25	7	55.5	46.5	9.0	
15	25	5	55.5	26.0	29.5	
17	25	8	55.5	66.0	-10.5	
19	25	8	55.5	66.0	-10.5	
22	25	3	55.5	14.0	41.5	
26	25	8	55.5	66.0	-10.5	
31	25	5	55.5	26.0	29.5	
33	25	7	55.5	46.5	9.0	
36	25	6	55.5	36.0	19.5	
37	25	2	55.5	8.0	47.5	
38	25	6	55.5	36.0	19.5	
1.	20	8	69.5	66.0	3.5	
16.	20	8	69.5	66.0	3.5	
18.	20	7	69.5	46.5	23.0	
23.	20	8	69.5	66.0	3.5	
30.	20	8	69.5	66.0	3.5	
36.	20	5	69.5	26.0	43.5	
37.	20	0	69.5	1.0	68.5	
3	20	8	69.5	66.0	3.5	
6	20	8	69.5	66.0	3.5	
13	20	8	69.5	66.0	3.5	
20	20	8	69.5	66.0	3.5	
21	20	8	69.5	66.0	3.5	
34	20	8	69.5	66.0	3.5	
39	20	6	69.5	36.0	33.5	
14.	15	3	78.5	14.0	64.5	
20.	15	8	78.5	66.0	12.5	
39.	15	2	78.5	8.0	70.5	
27	15	4	78.5	19.5	59.0	

$\Sigma d_i^2 = 67,896$

$\Sigma x^2 = \frac{N^3 - N}{12} - \Sigma T_x$ $\qquad \Sigma y^2 = \frac{N^3 - N}{12} - \Sigma Ty$

$\Sigma x^2 = 41,217$ $\qquad \Sigma y^2 = 40,329.5$

$$r_s = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma x^2 \, \Sigma y^2}} = r_s = \frac{41,217 + 40,329.5 - 67,896}{2\sqrt{(41,217)\quad(40,329.5)}} = .167$$

$r_s = .167$

where $t = r_s \sqrt{\frac{N-2}{1-r_s^2}} = 1.496$

for $r_s = .167$ and df = 78, t = 1.496 "p" is N.S.

Table 41

Appendix

Significance of the Difference Between the SAE scores (Test Performance) of "Organics" tested by E.M. (1960) and A.D. (1962) and "Organics" seen by A.D. (1962) only (Mann-Whitney U test, corrected for ties)

S No.	Organic SAE Score (seen by E.M. & A.D.)	Rank	S No.	Organic SAE Score (seen by A. D.)	Rank
1	8	33.5	6	8	33.5
2	8	33.5	16	8	33.5
5	8	33.5	20	8	33.5
9	8	33.5	21	8	33.5
12	8	33.5	30	8	33.5
13	8	33.5	31	8	33.5
23	8	33.5	40	8	33.5
3	7	23.5	17	7	23.5
4	7	23.5	18	7	23.5
24	7	23.5	33	7	23.5
10	6	18.5	15	6	18.5
35	6	18.5	38	6	18.5
25	4	13.0	34	5	15.5
26	4	13.0	36	5	15.5
28	4	13.0	7	3	8.5
8	3	8.5	19	3	8.5
32	3	8.5	27	3	8.5
14	3	8.5	29	2	4.0
22	2	4.0	39	2	4.0
			11	1	2
			37	0	1
$n_1 = 19$			$n_2 = 21$		
$R_1 = 410.5$			$R_2 = 409.5$		

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1 = 178.5$$

$$Z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\left[\frac{n_1 n_2}{N(N-1)}\right]\left[\frac{N^3 - N}{12} - \Sigma T\right]}} = .584$$

for Z = .584 "p" is N.S.

Table 42

Appendix

Trial by trial test performance of Organic Ss

r = right
w = wrong

S. No.	Test 1	Trial 2	Number 3	4	5	6	7	8
1	r	r	r	r	r	r	r	r
2	r	r	r	r	r	r	r	r
3	r	r	r	r	w	r	r	r
4	r	r	r	r	w	r	r	r
5	r	r	r	r	r	r	r	r
6	r	r	r	r	r	r	r	r
7	w	r	w	w	w	r	r	w
8	w.	w	r	w	r	w	w	r
9	r	r	r	r	r	r	r	r
10	r	r	r	w	r	w	r	r
11	w	w	w	w	r	w	w	w
12	r	r	r	r	r	r	r	r
13	r	r	r	r	r	r	r	r
14	w	w	w	r	w	w	r	r
15	w	r	r	r	w	r	r	r
16	r	r	r	r	r	r	r	r
17	r	r	r	r	r	r	r	w
18	r	r	r	r	r	w	r	r
19	w	w	w	r	w	r	w	r
20	r	r	r	r	r	r	r	r
21	r	r	r	r	r	r	r	r
22	r	w	w	w	r	w	w	w
23	r	r	r	r	r	r	r	r
24	w	r	r	r	r	r	r	r
25	r	w	r	w	r	w	w	r
26	r	r	r	r	w	w	w	w
27	r	r	w	w	w	w	w	r
28	r	r	r	w	w	w	r	w
29	w	r	w	w	w	r	w	w
30	r	r	r	r	r	r	r	r
31	r	r	r	r	r	r	r	r
32	w	w	w	r	w	r	w	r
33	r	r	r	r	r	r	r	w
34	r	r	w	r	r	w	r	w
35	r	r	w	r	r	w	r	r
36	r	r	w	r	r	w	r	w
37	w	w	w	w	w	w	w	w
38	r	r	r	w	r	r	r	w
39	w	w	w	w	w	r	w	r
40	r	r	r	r	r	r	r	r

Table 43

Appendix

Trial by trial test performance of Functional Ss

r = right
w = wrong

S. No.	Test Trial Number 1	2	3	4	5	6	7	8
1	r	r	r	r	r	r	r	r
2	r	w	r	w	r	r	w	r
3	r	r	r	r	r	r	r	r
4	r	r	r	r	r	r	r	r
5	w	r	r	r	w	w	r	r
6	r	r	r	r	r	r	r	r
7	r	r	r	r	r	r	r	r
8	r	r	w	r	r	r	r	r
9	r	r	r	w	r	r	r	r
10	r	r	r	r	r	r	r	r
11	r	r	w	r	r	r	r	r
12	r	r	r	r	w	r	r	w
13	r	r	r	r	r	r	r	r
14	r	r	w	r	r	w	r	r
15	r	w	r	r	w	r	r	w
16	r	r	r	r	r	r	r	r
17	r	r	r	r	r	r	r	r
18	r	r	r	r	w	r	w	r
19	r	r	r	r	r	r	r	r
20	r	r	r	r	r	r	r	r
21	r	r	r	r	r	r	r	r
22	w	w	w	r	w	r	r	w
23	w	w	r	w	w	w	w	w
24	r	w	r	r	w	r	r	r
25	r	r	w	r	r	w	r	w
26	r	r	r	r	r	r	r	r
27	r	r	w	r	w	w	w	r
28	w	w	w	w	r	w	w	w
29	r	r	r	r	r	r	r	r
30	r	w	w	w	w	w	w	w
31	r	r	r	w	w	r	w	r
32	r	w	r	r	r	w	r	w
33	r	r	r	r	r	w	r	r
34	r	r	r	r	r	r	r	r
35	r	r	r	w	r	w	w	r
36	r	w	r	r	r	w	r	r
37	r	w	w	w	w	r	w	w
38	r	r	r	w	w	r	r	r
39	r	r	w	r	w	r	r	r
40	w	r	r	w	w	w	w	w